HORTICULTURE IN SOUTH INDIA

K. C. Naik

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This series of textbooks is being published by the Directorate of Extension and Training, Ministry of Food and Agriculture, Department of Agriculture, Government of India, with the object of providing in a handy form detailed information on the various subjects taught in the Training Institutions working under the guidance of the Directorate. Written by well-known authorities in simple non-technical language and based on the proven results of research, these textbooks, it is hoped, will be of interest and benefit not only to the Extension trainees and instructors but also to the larger circle of agricultural students and general readers.

Editor

D. M. ANAND, M.A. (OXON)
Deputy Director (Information)

HORTICULTURE
IN SOUTH INDIA

(applicable to conditions prevailing in the States of Mysore, Andhra, Madras and Kerala)

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FOREWORD

It is well-known that Horticulture occupied a prominent place in the economy of India even as far back as the 4th century B.C. or even earlier. Nevertheless, due to a combination of various factors adequate attention has not so far been paid to it in the country.

It is obvious, however, that if the nation-wide programme of intensive rural and urban development which has been undertaken by the Government of India under the Five Year Plans is to be successful, urgent steps should be taken for building up the horticultural prosperity of the country. For this reason, the dissemination of scientific and practical knowledge relating to Horticulture in India is of the utmost importance.

I am, therefore, happy to see that the Directorate of Extension and Training has taken in hand the project of publishing a comprehensive textbook on Horticulture. This textbook will deal with the subject on a regional basis, viz., Northern, Eastern, Central and Southern, and will be written by recognised authorities. It will cover all the practices relating to Horticulture in the various parts of the country and will thus be of great practical value in ensuring the success of the schemes of horticultural training and development which are at present being undertaken in the country.

I am sure that this textbook written by well-known authorities in simple, non-technical language and based on the proven results of research, will be of interest and benefit not only to the extension workers for whom it is primarily intended but also to the larger circle of agricultural students and general readers.

M. V. KRISHNAPPA
Deputy Minister for Agriculture,
Ministry of Food and Agriculture
Government of India

New Delhi,
January, 1958

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PREFACE

Horticulture in India has not received due recognition because for long the main attention in the country has been focused on the production of foodgrains. Nevertheless, its importance can hardly be overestimated for the use of fruits in the dietary of a nation is indispensable for the proper maintenance of the health of the people. Not only fruits can supplement the food resources of a nation, but the use of these protective foods, which are rich sources of vitamins and minerals, is essential to ensure a balanced diet.

The minimum requirements of an individual for fresh fruits according to nutritional standards is two ozs per day but the actual consumption is considerably more in the advanced countries. The diet of the people of this country, however, is extremely deficient in fruits and the Indian villager hardly consumes any.

This is a state of affairs which needs to be remedied and it is obvious that if the whole programme of intensive rural development, which is comprised in the National Extension Service and Community Development Programme, is to be successful, the expansion of Horticulture in our rural areas should receive due attention.

Good work has been done by the State Departments of Agriculture in most States in the field of Horticulture, and at the Horticultural Research Stations of the State Governments important results have been achieved which can form the basis of extension work in Horticulture on a large scale. It was hence decided that the *Gram Sevaks* should receive full training in Horticulture.

The Extension institutions, working under the guidance of the Union Ministry of Food and Agriculture, have, therefore, undertaken a comprehensive programme of training in this sphere, so that the *Gram Sevaks* may learn all the cultural practices relating to fruits, particularly how to multiply plants by layering, grafting, etc; application of manures and irrigation; methods of pruning; preparation and application of insecticides and adoption of plant protection measures.

But in this programme, the lack of good textbooks was felt as a serious handicap. The Directorate of Extension and Training, Ministry of Food and Agriculture, therefore, undertook the project of publishing a comprehensive textbook on this subject. For this purpose, the whole country was divided into four regions, viz., Northern, Eastern, Central and Southern, and a recognised authority was assigned the task of preparing a textbook on Horticulture in each of these regions. It was thus hoped to cover all the practices relating to Horticulture, which differ in the various parts of the country, according to the soil, climatic and other conditions, and produce an authoritative standard work which would serve both as a textbook as well as a work of reference.

Dr. K. C. Naik, who was assigned the task of writing on "Horticulture in South India", is the first to have completed his assignment. He is a well-known horticulturist, who commands respect among scientists as well as fruit growers and I am glad that he has provided us with useful material of practical value. The book has been ably edited by Mr. D. M. Anand, M.A. (Oxon), Deputy Director of Information, Directorate of Extension and Training, Ministry of Food and Agriculture.

I am sure that this textbook written by a well-known authority, in simple, non-technical language, and based on the proven results of research, will meet a long-felt need, and be of interest and use not only to the trainees in the Extension Training Institutions but also to the larger circle of agricultural students and general readers.

New Delhi,
January, 1958

M. S. RANDHAWA, D. SC., I.C.S.
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AUTHOR'S PREFACE

It is difficult to claim that there are many good and authoritative books on the subject of Horticulture in India. Good books on Horticulture written by foreign authorities are of value only to those who are not directly concerned with the practical aspects of Horticulture. The absence of a practical and comprehensive work on gardening in India has been a problem not only during the days when *Firminger's Manual of Gardening for India* was published in 1863, but continues to be so even to this day. Whatever the causes for this may be, the need for a practical guide to Indian Horticulture cannot be overemphasised. The need is far greater now than ever before, with the nation-wide measures that have been taken for the uplift of the country through a very intensive programme of rural and urban development. Horticulture has almost a determining role to play both in the improvement of the countryside and of the towns and cities of India. The art and craft of horticulture grows not merely through enthusiasm and skill, but must be built on the sound and stable foundation of scientific knowledge. Planning for the dissemination of scientific and practical knowledge, with measures to foster the skill and enthusiasm of the people, is necessary for building the horticultural prosperity of a country.

The aim of this work is to contribute its share to the success of the schemes for horticultural training. To bring within the small compass of this work scientific knowledge and practical experience on such a large number and variety of subjects and crops, is no light task. Unfortunately, precise knowledge based on experiments is not available on many aspects of Horticulture. Much that is contained here is from experience both recorded and unrecorded and much has had to be deduced from observations and reports.

Reliance chiefly on published horticultural works becomes inevitable and, therefore, the bulk of this hand-book is drawn from such works. It is perhaps not necessary to mention all these innumerable sources in a compiled book of this nature. However, the author considers that his gratitude to Shri A. R. Seshadri, M.A., Lecturer in Entomology, Shri C. V. Govindaswami, B. Sc. (Ag.), Assoc. I.A.R.I., Lecturer in Mycology and Shri B. S. Kuppuswamy, B.Sc. (Ag.), D.I.H. and Shri R. Bettai Gowder, B.Sc. (Ag.), D.I.H., Assistant Fruit Specialists of the Madras Agricultural College and Research Institute, Coimbatore, who have rendered valuable assistance in compilation of certain portions of this book, cannot go unrecorded. Recognising the numerous limitations under which this work has had to be compiled, the author does not see the need to apologise for the many imperfections in this book, but shall be grateful to anyone for advice or suggestions, so that these may form the basis for improvement not only in the content and quality of this book, but also in the instructions in Horticulture to our *Gram Sevaks* for whose benefit this is primarily intended.

K. C. Naik

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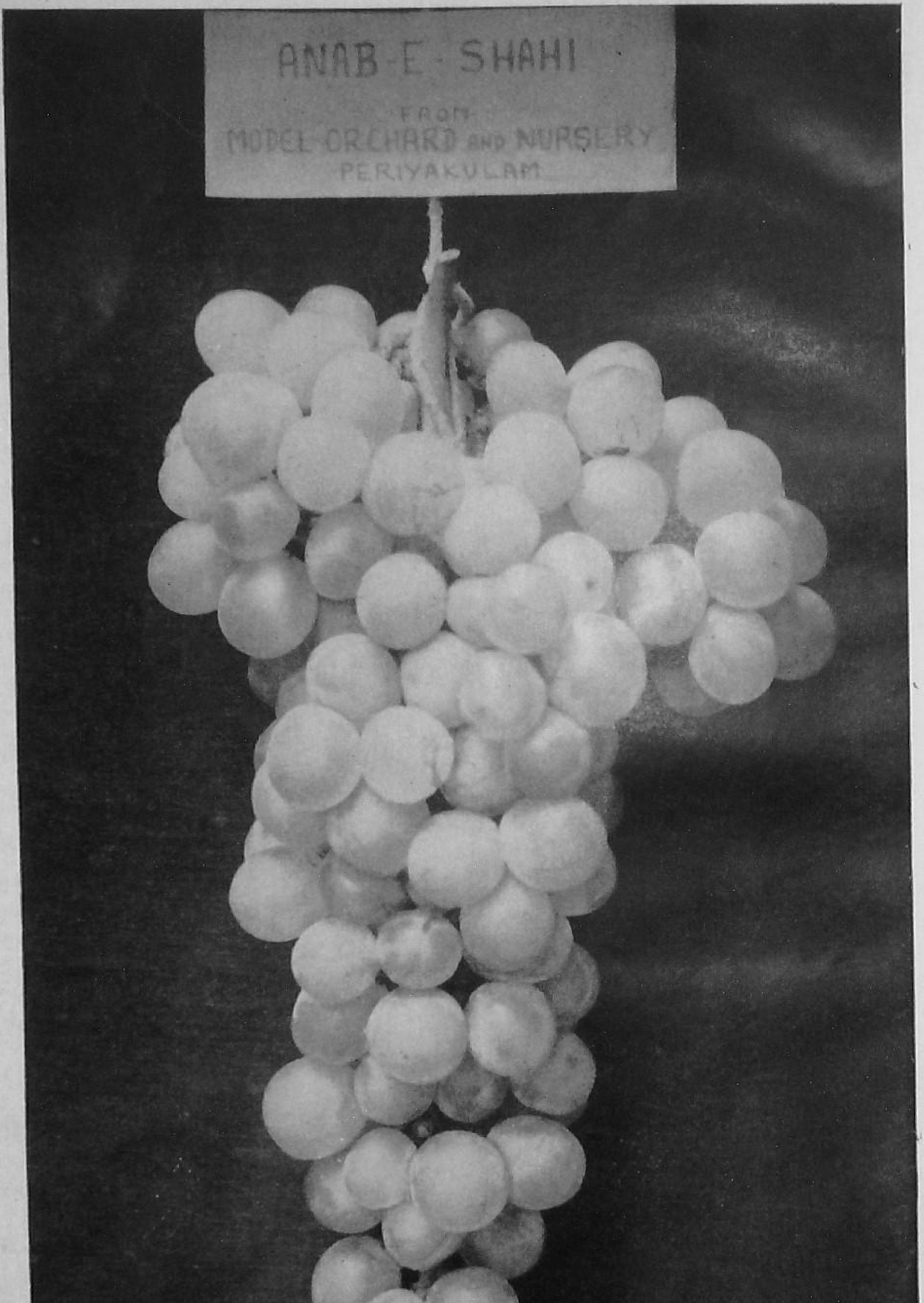
PART I

FRUITS



Anab-E-Shahi,
a promising grape of South India

CHAPTER I

INTRODUCTION

Importance of Fruits

From times immemorial fruits have figured very prominently in the life of this country. Jawaharlal Nehru has referred in his book, the *Discovery of India,* to the fact that horticulture was a prominent avocation in India even as far back as the Fourth Century B.C. or even earlier.

In most parts of the world, fruit growing has gradually developed from the primitive ways of life to one of the most civilised, skilled and worthwhile forms of land utilisation. It requires a far more developed mind than is needed when pastoral or cruder forms of agricultural farming are the rule or when hunting and fishing are the main sources of human food supply.

Fruit growing is so fascinating that it claims patrons from all classes of people, many of whom are content to practise it just as a hobby without any regard for the returns. Planned fruit culture adds to the aesthetic richness of rural and home life.

The economic aspect of fruit growing is no less important. Many countries such as the U.S.A., Israel, Spain, Italy, Australia and South Africa count fruits either among the leading exportable commodities or the main sources of national wealth.

With vegetables and milk, fruits are ranked among the leading protective foods for fostering human health. Both for their vitamin contents and for minerals, fruits are essential for the well-being of mankind. The pectin and cellulose in several fruits are helpful in promoting digestion or bowel action. Many fruits are also considered to be of

medicinal value. Above all, fruits are most appealing and enjoyable of foods, in addition to being nutritive and healthful.

The yield of food per unit area through fruit growing has not been excelled by any other crop. Yields ranging up to 40,000 lb of bananas, 60,000 lb of grapes, 30,000 lb of papayas, 25,000 lb of pineapples are well-known as against the maximum of 12,000 lb of paddy per acre per year. An individual tree bearing 12,000 fruits of lime and as many or more mangoes or sapotas is not unknown. It is not beyond the wit of man to have all the trees in a plantation bearing similarly high crops. These facts show how valuable fruit growing is in any programme of economic and rational utilisation or transformation of land.

Fruit growing is of special value in the industrialisation of a country for it serves as the mother of many industries, such as soft drink or fermented beverage, canning, jams, dehydration, pickles, vinegar, etc.

Unlike agriculture, fruit growing provides all the year round occupation. There is, therefore, no problem of seasonal unemployment.

A diversified system of farming is necessary for the economy of every country. In fruit growing, we have an avocation which is ideally fitted to our economy. Nature has endowed India with conditions most suited for the cultivation of such a large number of fruits that there is hardly a parallel in any other part of the world. But systematic and scientific fruit improvement has not received much attention in the country until lately, and imports of fruits or fruit products continue to the tune of nearly three crores of rupees per year. A few books published recently such as *Fruit Growing in India* by W. B. Hayes, *South Indian Fruits* by K. C. Naik and *Commercial Fruits of India* by Cheema, Bhat and Naik indicate the growing awareness of the role of fruits in our national economy. The present work aims merely to be a compilation of the available knowledge from all possible sources, more especially from the published and unpublished records of the Departments of Agriculture and the books mentioned above.

CHAPTER II

SELECTION OF SITE

Climate and Soils

Where to grow is as important as what to grow. In fruit production, success depends to a very large extent on the choice of a site and on the favourable combination of soil and climate. It is not always easy to modify the climate or soil, and even if it were possible to some extent, the cost involved is generally prohibitive. Perennial crops to which most fruits belong, remain on the same site for many years and, therefore, a mistake committed in selecting a site cannot easily be undone. Often the defective site becomes a growing liability. A careful and discriminating fruit grower has, therefore, to be most cautious in choosing the site for his orchards.

CLIMATE : This constitutes several basic environmental elements such as rainfall, humidity, temperature, wind, light, etc.

Rainfall : The rainfall influences fruit growing both by amounts of rain and its distribution. Most of the Indian fruits are irrigated but there are also considerable sections where fruit growing is dependent entirely or almost entirely on rainfall. The Malnad areas of South India and the West Coast of South India which are characterised by heavy rainfall are able to produce many fruits mainly with the help of rainfall. The mandarin oranges, jacks and pineapples of Malnad, the mangoes, sapotas, some bananas, pineapples, etc., of the West Coast provide instances of a large number of fruits that are being raised without any special irrigation facilities. Even outside these areas certain fruits require little or no irrigation, while others can be grown under certain situations without much dependence on artificial irrigation. The perennial banana groves of Tanjore district and of the lower Palnis, the mango plantations in almost all

parts of South India are examples of such commercial fruit farming under unirrigated conditions.

Subject to the above broad demarcations, it may be stated that heavy rains are generally unfavourable to fruits, as they lead to water logging and even to more severe damage, if accompanied by high winds. Blossom and fruit dropping are caused by rains occurring at particular periods. It has become necessary to harvest mangoes before the rains commence in June on the West Coast, though some hardy varieties like the Neelum are able to mature a small crop of fruits even during the rainy season in that area. Under heavy rains and high humidity, fungal and bacterial diseases of fruits also gain the upper hand. Low rainfall or scarcity is also a disadvantage as this would lead to higher irrigation cost. All this shows the great importance of determining a site where adequate irrigation facilities are available to supplement the rains at least in such critical periods as the summer months or during dry spells.

Humidity : High atmospheric humidity is necessary for the success of several tropical fruits like mangosteen, jack fruit, bread fruit, etc. In many other fruits, however, excess of atmospheric humidity has an adverse effect on fruits, particularly on colour and keeping quality. Increased fungal and bacterial diseases also result, besides growth of such plant parasites as loranthus and lichens. High humidity, however, may extend to short or long periods. Where there is a sudden or excessive change from one condition to another, the growing of fruits becomes particularly difficult. This is specially so in places where an excessively dry summer is followed by a very wet or humid rainy season.

The change from dry to humid conditions does not come uniformly in all years. A few summer showers and cloudy days may moderate the severity of summer in some years, while in others a continued period of drought may suddenly be succeeded by the fury of the South-west monsoon. Where such abrupt changes occur after a succession of normal seasons, all perennial plants including fruit trees face an extremely difficult period. Under such circumstances, it is

not uncommon to find large scale or wide-spread distress in fruit orchards or plantations, which had apparently been thriving for a number of years. Although sudden climatic changes cannot be predicted or forecasted years ahead, a fruit grower will find it advantageous to study the past weather conditions before taking up a large scale orchard enterprise in any locality. The failure of a large number of mandarin orange plantations in parts of Wynaad in the West Coast of South India in recent years has been attributed in part to the violent climatic fluctuations. Such consequences also follow under localised conditions, resulting in the rapid distress or death of well-grown trees, following abnormal changes in the climatic condition.

Temperature: This is perhaps the most important elementary factor determining the degree of success or otherwise of a crop. Every fruit can be said to demand a range of temperature, below or above which it is bound to suffer to a smaller or greater extent. Mangoes, bananas, pineapples and jack fruits are instances of crops suited to tropical conditions, where high temperatures prevail, just as apples, pears and strawberries are fruits suited to temperate regions with relatively low temperatures. It is true that varieties differ in their tolerance or adaptability. Thus, certain hardy varieties of apple may be grown, though not as a paying crop, even in South India at certain elevations, but the growth and cropping of even such hardy varieties of apple are very poor in this part of the country as compared with the performance of most of the apples in temperate regions like Kashmir, Panjab, Uttar Pradesh in India or parts of Europe, America, etc. Similarly, tropical fruit trees like the mango get seriously injured when temperatures go abnormally low near the freezing point i.e. 32° F, and the younger plants of most of the mango varieties when planted in the open may be killed when the temperature goes down to that level even for a few minutes. During sudden frost occurrences in the tropical areas, large scale casualties of tropical plants and fruits are, therefore, commonly experienced. In the same way, a sudden and excessive rise

of temperature in a temperate zone may seriously throw an apple or a pear tree out of balance, thus affecting its performance. Early advent of summer, leads the apple and pear trees to a premature break from their resting periods. Such a sudden change from dormancy to growth activity is reflected by a sudden burst of growth from the dormant buds leading to increased vegetative activity rather than fruitfulness associated with the timely emergence of well-formed and well-developed flower buds.

Attempts have been made to grow fruit trees under controlled temperature in glass houses but this is a different type of avocation which is beyond the scope of an average fruit farmer. A study of the temperature variations over a number of years in the past would help an intelligent, prospective fruit grower to have a rough estimate of the risks or hazards. In some countries, very expensive measures have to be taken to save the fruit trees or their crops from any sudden temperature changes such as snow falls, frost occurrences, hail-storms, etc. Apart from the selection of accommodating varieties to each situation, measures are also taken to protect fruit trees in their early periods against the rigours of abnormal seasonal conditions. Thus, on higher altitudes and in places where temperatures go fairly low in winter, temporary protection to young plants through a covering of twigs, grass, straw or gunny wrappings either during cool nights and mornings or sometimes throughout the period when low temperatures prevail, is usually provided. In the same way, protection from direct rays of the sun is secured for young plants through low *pandals* erected for short periods for providing the necessary shade. High temperatures not only lead to the rapid diminution of soil moisture but may also cause injury to the young leaf, flower and fruit. Generally speaking, however, under normal conditions of growth relatively higher temperatures tend to promote increased sugar content in fruits. Another commonly manifested feature under relatively low temperature conditions is the delayed emergence of blossoms and the slower development of fruit. The season of harvest may, therefore,

be influenced appreciably by the prevailing temperature from the time of the formation and emergence of blossom.

Wind : High winds or cyclones form a serious limiting factor in successful fruit production. If, therefore, fruit growing has to be carried out in cyclone-infested tracts, special precautions are necessary to prevent the possible damage. Raising of thick wind-break belts, selection of sites naturally protected from high winds, such as valleys or spots nestling between high hillocks or well-wooded areas, planting of varieties which can withstand or resist high winds and measures to give props or artificial supports to the tree are some of the important steps that are required to be taken. In the cyclones that ravaged the Coramandel Coast in 1952 and 1955, it was found that the dwarf Mauritius and the culinary Bontha varieties of banana withstood the damage far better than the popular Poovan. In tree fruits also some varieties are able to tenaciously hold their fruit crops, while in others the fruits shed or fall off with a gust of wind. Breakage of limbs, tree deformities, such as marked bend towards the wind direction, are the other results of inadequate protection against high winds. Fortunately, however, South India is free from violent dust storms or hot desiccating winds which become the limiting factors in some other areas.

Light : It is well-known that fruits produced under thick shade are less attractive than those exposed to light. But light can also be too strong and injurious and may cause disfiguration of the fruit. In extreme cases direct rays of strong sun for long periods result in sun scorch of the fruit or tree parts. Sun scorch sometimes leads to deformed fruits, cracking of the bark and even entry of decaying organisms. All these compel the fruit grower to regulate the light to his best advantage. By adjusting the space between trees, by pruning and trimming of the trees, by regulating the planting of intercrops of trees specifically intended to give shade, and similar devices, the grower has to ensure that the production of sound, properly coloured, attractive fruits is facilitated. In temperate zones, the absence of light is at times a

disadvantage for the growth and performance of fruits. But in the tropics, excess of light is sometimes the limiting factor. Therefore, a similarity of orchard practices cannot be expected to yield identical results under such diverse conditions.

CLASSIFICATION ACCORDING TO CLIMATE : Although fruits are often classified for convenience as (1) Tropical fruits, (2) Sub-tropical fruits and (3) Temperate region fruits and these may further be subdivided into dry, wet, or humid zones or hills and plains, such classification requires to be modified when we deal with any given region. So far as South India is concerned, the usually recognised climatic divisions from the view-point of fruit growing conditions are as under :—

(i) *Hill fruit zone:* The Nilgiris, Upper Palnis, and all such high elevations exceeding about 5,000 ft from the mean sea level, represent this zone. Here some varieties of apple, pear, strawberries, plum, peach, etc., can be grown.

(ii) *Malnad areas:* This is a large area with a slightly higher elevation than the plains but below the 5,000 ft level and enjoying relatively higher rainfall and higher atmospheric humidity. It may properly be called the cool-to-warm humid zone, such as that represented in the well-wooded areas of Coorg, Mysore, Lower regions of the Nilgiris, Shevroys, Palnis, Nelliayampathis, Anamalais and several other ranges of the Western and Eastern Ghats. Mandarin oranges, pummeloes, jack fruits, pineapples, several varieties of banana and papaya thrive here, while in some specially favoured localities the mangosteen, durian, litchi, rambutan and avocado also grow well.

(iii) *Lower elevations of the West Coast:* This is a heavy rainfall tract generally below 2,000 ft and covering large stretches of the western sea board, producing a bulk of the early mangoes, bananas, particularly of the Nendran group, pineapple, jack, cashew, sapota and a host of minor fruits.

(iv) *The dry region:* Characterised by low rainfall of about 50″ per annum or less, this comprises the largest area in South India, where the mango, banana, sapota, sweet-

orange, lime, lemon, grape, guava, cashew, jack and many other tropical and sub-tropical fruits can be grown, mainly under irrigated conditions.

The foregoing divisions, however, are too rough to be adopted as the basis for selecting fruits for an orchard. The suitability of a fruit to a given site is conditioned by a very large number of factors and the rough division of a region can afford no correct guidance. In fact, the best way of selecting a variety for a given site is on the basis of the actual performance of that variety in the neighbourhood. Actual varietal tests, backed by local experience, form the pre-requisites to successful fruit growing.

SOILS: The soil also plays a leading role in fruit production. Most of the fruits live for many years on the same site, and a deep soil of proper structure, texture and constitution is essential for satisfactory growth and performance of these trees. Unlike seasonal agricultural crops, which generally depend on the surface soil for their nutrients, fruit trees have to send their roots deep down to the lower layers in search of food and moisture. It is, therefore, a mistake to imagine that a soil good for an annual will suit a perennial crop.

Physical conditions: The physical condition of the soil is of special importance for fruit trees. In very stiff soils, such as some of the black cotton soils, both the movement of soil moisture and air is impeded, while in very open or highly sandy or gravelly soils the opposite extreme is met with. A loamy soil, where root growth is easy and neither water stagnation nor rapid soil moisture movement is found, and where aeration is the optimum, is, therefore, preferred for fruit growing, provided the soil is at least six feet in depth. It is true that some trees go far deeper in search of nutrients and moisture, but a vast majority of the feeding roots are found within the six feet depth. Within this six feet layer, however, soil should be of as uniform texture as possible. This is important, as any marked disparity in the feeding zone of the tree is found to affect the tree adversely. Such variations lead sometimes to the starvation of a part of the

roots for lack of soil moisture or food, while another part may be suffering from excess saturation, consequent to which there may be inadequate aeration and other factors which foster certain pathological conditions. A sandy soil underlain with a clay soil is as much to be condemned as clay superimposed over a sandy or gravelly substrata. A moderately open textured soil, uniform to a depth of about six feet, is, therefore, deemed ideal for fruits. Shallow soils, or soils with hard layers below a few inches from the surface, are the general feature of orchards which have failed or yield uneconomic crops. Trees usually remain dwarf in such soils. Digging of trial pits up to six feet depth for a close and careful examination of soils forms, therefore, a pre-requisite for a successful orchard venture.

Almost the same consequences as are met with in shallow soils, are experienced by fruit growers who have raised their orchards in soils with a high water table. Trees do not tolerate 'wet feet' to the same degree, and while many wither and die by over-saturation of the soil even for a few minutes, others may stand a similar condition for many hours without apparent signs of distress. Planters of Vadlapudi oranges in the clay or loamy soils of the Circars have found that premature death is the result if the trees are set out in sites where the water table rises within about four feet, while the same feature has been experienced by Sathgudi orange growers on the Sirvel side of the Rayalaseema even when these trees were planted in light loamy soils but with a water table rising within three or four feet from the surface. Thousands of jack fruit trees died when with the canal irrigation the water table in a part of the Cauvery delta rose up to a few feet from the soil surface, even though mango trees showed no signs of distress under the same conditions.

Chemical conditions: The chemical composition of the soil is known to determine the nature and character of vegetation or cropping. A highly alkaline or saline soil has no agricultural or horticultural value, unless the excess of salts is removed and conditions are so improved as to make cropping possible. So far as fruit trees are concerned, it is now

recognised that soils of neutral reaction are about the best. It is true that some trees may tolerate a slightly acid or alkaline medium, but the limit of tolerance for each variety of fruit is not accurately known in most cases, and it is, therefore, a safe procedure to rule out all sites which are known to be markedly acidic or alkaline. It is possible to improve the soils which are only moderately acidic or alkaline, but in such soils the opinion and advice of a competent soil chemist are necessary before the final selection of the site for fruit-growing is made. Soils with a high concentration of soluble salts are easily detected by the incrustations or deposits on the surface and the absence or character of vegetation. But this sort of test is not adequate to judge the suitability of a site and is no substitute for chemical analysis.

Generally speaking, most of the soils on the West Coast and Malnad areas are of a slightly acidic character, while most of the soils in the drier regions of South India are alkaline. Soils which on analysis show a pH value of 9 or over are considered generally as highly alkaline, while those with a pH value of four to five or below as highly acidic for fruit growing. There are, however, fruits which tolerate acidity or alkalinity to a greater extent than others, as already stated, and there are also soils whose nature or character can be modified by soil treatments or appropriate orchard practices. In all these matters, expert chemical and horticultural advice is essential.

Soil fertility is given some importance in site selections, but this is a feature which is subject to considerable modification by the grower. Where all other conditions are uniform, a soil of naturally high fertility is to be commended. But no site need be rejected merely because it is low in fertility. By regulating the soil culture and manurial applications the fertility of any soil can be enhanced gradually. Addition of fresh soil or tank silt is one method, but this may be expensive in many cases. A regular programme of green manuring, supplemented by other appropriate manurial applications, depending upon the nature of the soil and the crop, must be chalked out for improvement of soil fertility, if necessary.

Soil colour is often given far more importance than it deserves. The colour may be an indicator of the presence or absence of certain chemicals, but is no criterion for judging its texture or fertility or its suitability for a crop, by itself.

OTHER FACTORS FOR SITE SELECTION: Though climate and soils are the most important, the grower must consider many other factors before finally selecting the site for his orchard. Among these the following are specially noteworthy :—

Availability of water for irrigation in adequate quantities, particularly during critical periods such as the summer months, and of a quality which will not be injurious, is no doubt of the highest importance in irrigated fruits. But the actual cost on irrigation is equally important and should be estimated accurately before the selection of site is made. The cost on transport of the perishable orchard produce is of equal importance. The possible damage to fruit trees from cyclones, hail storms, from disease-infested plantations nearby, has also to be assessed and the cost on prevention or avoidance of such loss or damage estimated. The cost on layout of the land and the preparation of the soil are other items of cost that have to be determined. Above all, there is the price of land to be paid, which if excessive, will be a permanent handicap. The availability of social, medical, educational and other amenities are also of no mean importance in the selection of a site for a permanent vocation, such as fruit-growing.

Chapter III

PROPAGATION

Nursery Practices

Propagation by seed: Most plants, excepting those which are seedless, can be raised from seed. Such plants may or may not resemble the seed parents in important respects. Thus, seedlings of some mango varieties like Alphonso, Pairi, Mulgoa, Baneshan, Neelum and Bangalora cannot be expected to produce fruits similar to the seed parent. Generally, the fruits from the seedling trees are inferior to and differ markedly from the fruits of the mother tree in size, shape and eating quality. Therefore, raising of seedlings is not a wise practice for commercial orchards of these varieties, which produce only one embryo in their seed and consequently give rise to only one seedling per seed. Such varieties are known as mono-embryonic.

There are, however, some varieties of mango like Olour, Kurukkan, Chandrakaran, Bappakai and Mylepelian which possess more than one embryo and are capable, therefore, of producing more than one seedling from every seed, ranging from two to five and occasionally even more. Of these, only one is sexually produced, being the result of fertilisation. Since no fertilisation is involved in the other cases, and since in the mango most of the sexually produced seedlings do not survive in the poly-embryonic varieties, these seedlings are true-to-type vegetative offsprings of the mother tree. We have in these poly-embryonic mangoes a means of raising seedlings similar in all material respects to the mother tree, reproducing the varietal characteristics in the fruits produced by the progenies.

The hybrid seedlings, which are the result of cross fertilization have, however, a value of their own. Most of the mango varieties we have today, have arisen as a result of chance crossing in nature. When a very large number of seeds, which

are the result of such chance crossing or deliberate crossing between different varieties, are sown, we do get occasionally a variety superior to either the mother or the male parent. Such superior trees can be multiplied and perpetuated by grafting or budding.

All methods of propagation that do not employ seed, are known as vegetative or asexual methods. Some of the common methods employed in this country are dealt with below.

1. *Cuttings:* A shoot or limb or root of a plant can be cut to produce pieces or cuttings of the size required, and these when planted in a suitable medium, may produce plants, which are true-to-type offsprings of the mother plant. These cuttings can be very small, containing only one bud or they may be about 9″ to 12″ long or even longer. They may be with or without leaves or only partially covered with leaves at the time of planting. Even cuttings of leaf can be used in some plants, though in fruit nurseries the cuttings employed are usually taken from well-ripened, one-year-old wood. Even older wood from large limbs, however, is sometimes used. Root cuttings are used only in guava and seedless bread-fruit, while grape, fig and pomegranate are commonly propagated by shoot cuttings removed from the ripened wood of the previous season's growth. The plants which are used as live stakes in grape pandal i.e., the *Erythrina* and *Commiphora* are usually raised by large limb cuttings, which strike root readily if planted in a rainy season. In the case of all cuttings, the upper cut is given a little above a bud while the lower cut is sloping and is made just below a bud. The cuttings are planted in pots or nursery beds either straight or in a slanting position, burying about three-fourths of the cuttings inside the soil. The cuttings should be watered carefully so as to wet the soil completely all around the buried part of the cutting.

Some fruits like the mango, sapota and cashewnut do not root easily when propagated by cuttings. In such cases, a thin strip of bark is removed all around at the place where the roots are to emerge. Over this ringed shoot or limb, callus

growth occurs whereupon the shoot or limb is cut off with the roots and planted in the soil or pot. Cinchona produces roots easily with this treatment.

Of late plants which are difficult to root have been found to respond when subjected to certain chemical or hormone treatments and a number of proprietary substances are being advertised as useful for root inducement. Indolyl acetic acid, naphthalene acetic acid and their compounds, cow's urine, brewer's yeast are some of the substances used with varying results.

Semiripened or soft wood cuttings are also found suitable in some plants. Cuttings of small size, even with only one node or bud have been used with success in some plants. When a lateral shoot is used as a cutting, it is sometimes found useful to retain a heel i.e., a small portion of the wood from the shoot from which emerges the lateral shoot.

There is a belief that cuttings produce shallow rooted plants in comparison with seedlings. Whether this is founded on fact in the case of our fruit trees, is a matter that has yet to be investigated fully.

2. *Layering:* Many plants including jasmine, Boguinvillea, lemon, grape and guava can be raised by layering. This is a process wherein a shoot or stem is treated to produce roots at a fixed region, to give rise to a rooted plant. The selected shoot or stem is buried in the ground or in a pot, as such or after exposing a part of the inner wood. A sharp and clean cut to form a tongue, or removal of bark in the form of a thin ring around the stem or shoot is the usual treatment given prior to the burying of the treated region in the soil or pot. For raising apple grafts, an improved method has been devised to raise the stock plants on which the grafts are to be made. This consists of planting young plants in a slanting position; and after they are established they are bent down to a horizontal position over the ground and pegged down, covering the bent portion with a layer of soil. The new shoots from the covered portion not being exposed to light, get etiolated and this facilitates root emergence, consequent to which the method is known as etiolation method of layering. The rooted

growths are then separated out to be planted individually in fresh sites. A modified method tried successfully with cinchona on the Anamalais is known as stooling. In this the plants to be multiplied are cut back or coppiced and the new shoots that emerge are covered by soil to induce etiolation and rooting.

3. *Gootee or Marcottage* is also a modified system of layering, in which the shoot is sliced or ringed and then the treated portion is covered with moss or a mixture of soil and other ingredients and finally wrapped over and kept moist to induce root formation. Recently special wrappers have come into use such as those of *alkathene*. Various other devices have been tried such as to hang a pot above the treated portion, fill it with water and then allow the water to trickle down along a string to the gunny wrapped *gootee*.

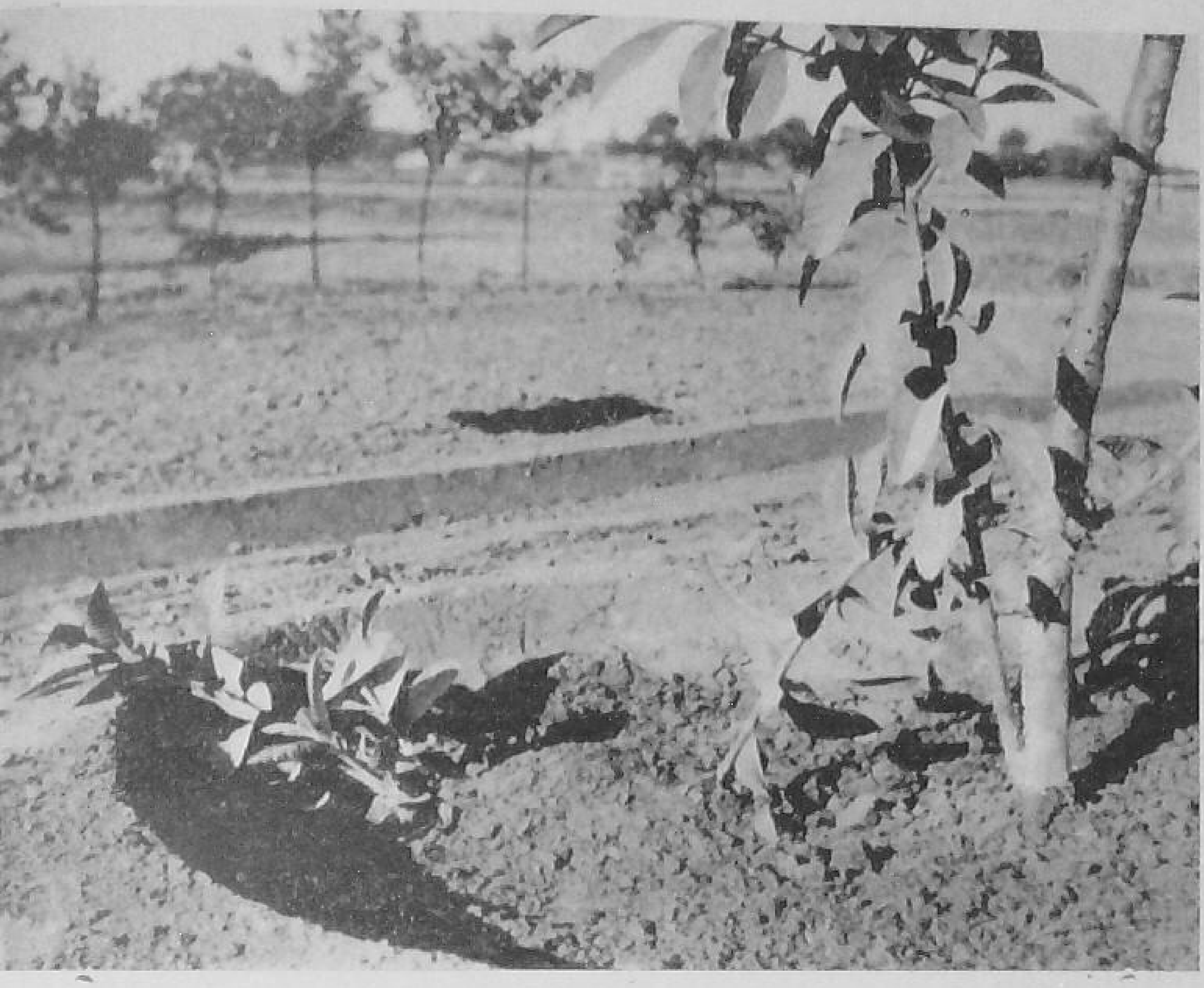
Both in layers and *gootee* the separation of the rooted parts is done after root formation is adequate, by cutting just below the treated portion with a sharp knife.

4. *Offsets or suckers:* Banana, pineapple and date are some of the fruits propagated by suckers or offsets. These may arise from underground parts as in bananas, or near the ground from stem portions as in the date palm, or from both as well as from the crown in the form of a tuft of leaves as in pineapple. Citrus and guava are other fruits which occasionally give rise to root suckers which can be separated out and planted, each to grow as a new tree. Injury to the roots sometimes promotes sucker growths in these fruits.

5. *Runners:* Strawberry is raised by runners which are parts of the mother plant capable of producing new roots when in contact with the soil, after which they can be separated out and planted.

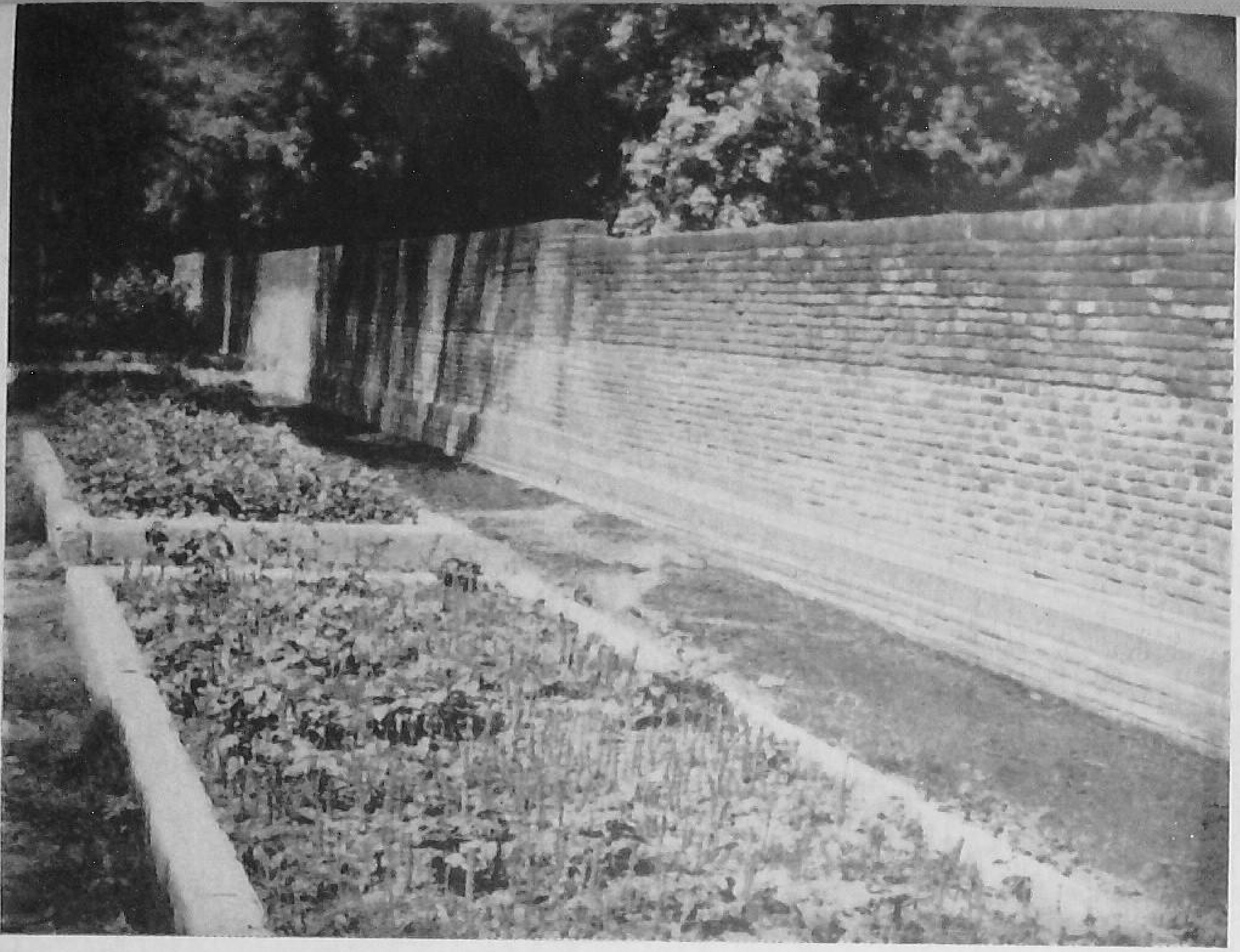
6. *Clumps or Splits:* A strawberry plant develops as it grows a large clump, parts of which can be split up and planted out to raise new plantations.

7. *Inarching:* There are several methods of grafting, all of which involve the union of two independent plants or plant parts. Thus, a Neelum mango shoot can be grafted



Layering

Gootee



A brick wall flanked by a row of thickly planted trees makes an effective windbreak belt

An earthen pot with a drainage hole at the bottom, to be covered by a piece of broken pot, before filling with soil and other ingredients

over a mango seedling raised from any mango. The seedling or plant over which a shoot is grafted is known as the rootstock, while the shoot grafted over it is known as the scion. The grafting commonly employed in South India for propagating the mango is called inarching.

In this the seed is first sown to raise a seedling. When this attains an adequate age or size it is transferred to a pot and after it is established in it, is carried near the tree from which the scion shoot is selected. The potted seedling is placed close to the selected scion shoot in a convenient position and then a small piece of bark with a bit of wood is sliced off. A corresponding slice of bark and wood is taken off the selected scion shoot and then the two treated portions are brought into contact and tied firmly. The exposed regions of the rootstocks and scion should be of the same size and when joined together should fit perfectly. They are then bound together with some fibre, raffia or similar material, after which a poultice made of a mixture of one part of soil of fine texture, one of clay, one of sand and one of cow dung is applied all over the bandaged part. When paraffined cloth is used such an application is unnecessary. Special preparations of grafting wax are also prepared by some, common one being a mixture of resin, beeswax, tallow or linseed oil in different proportions. After a period of two to four months, the scion shoot is separated out from the mother tree just below the point of union and the graft is removed. It is common to give one cut half way through the scion shoot about an inch below the union a month before and another on the opposite side a little above or below the first cut, to prepare the graft for the final separation and to reduce the shock of complete severance from the scion tree.

Grafts by the above method can be prepared by using portions of root as rootstock. Root grafting is largely practised with fruit trees grown in temperate region when the trees are dormant. With some treatments to harden the plant to withstand exposure of a portion of the rootpiece, root grafting has been found possible even with an evergreen tree like the mango.

2

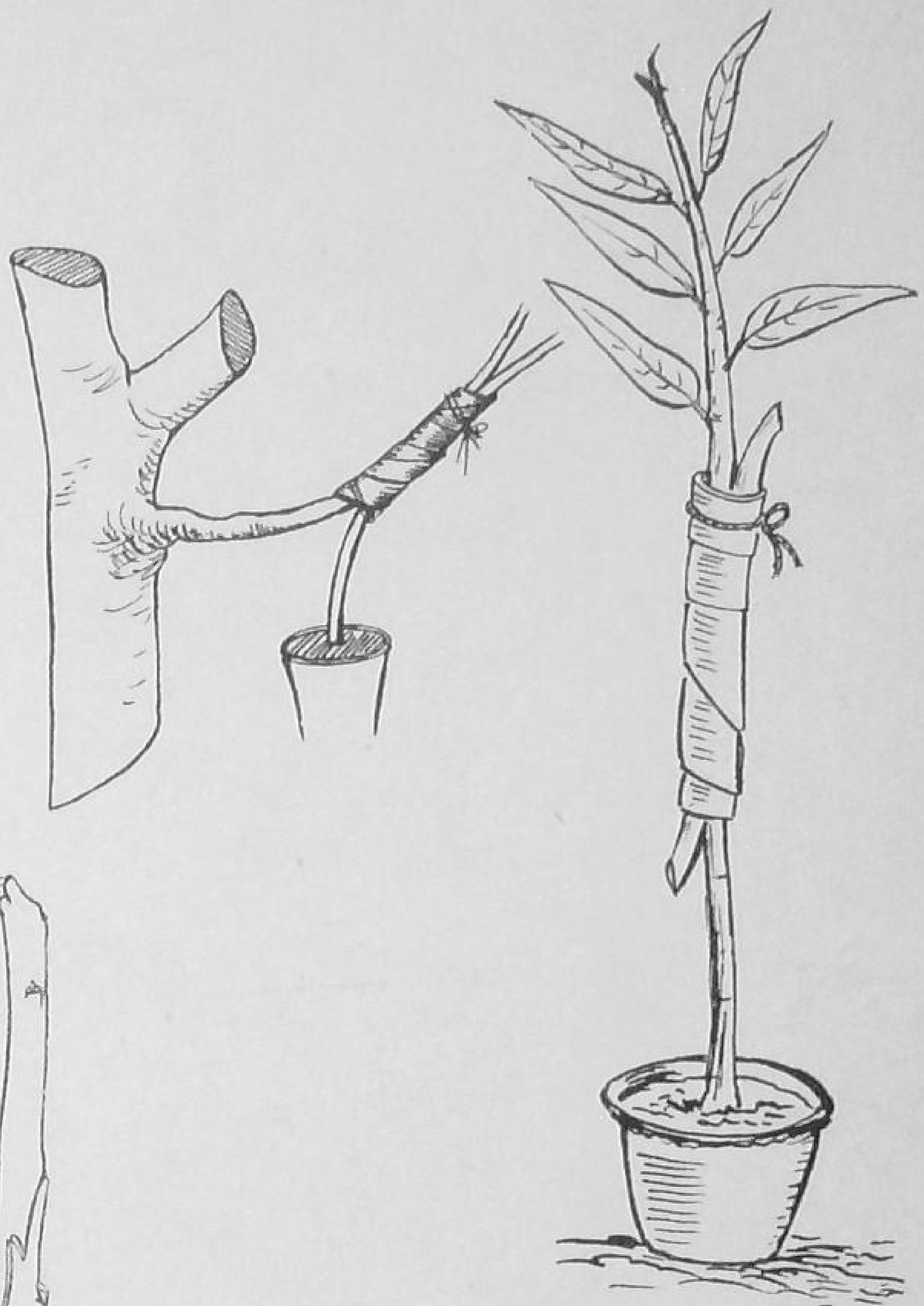
There are many instances of plants planted close together, uniting to form a single tree by sheer force of mechanical contact. The famous mango tree growing within the precincts of one of the Conjeevaram temples is believed to be an instance of union, due to which this apparently single tree is found to bear fruits of different sizes and quality.

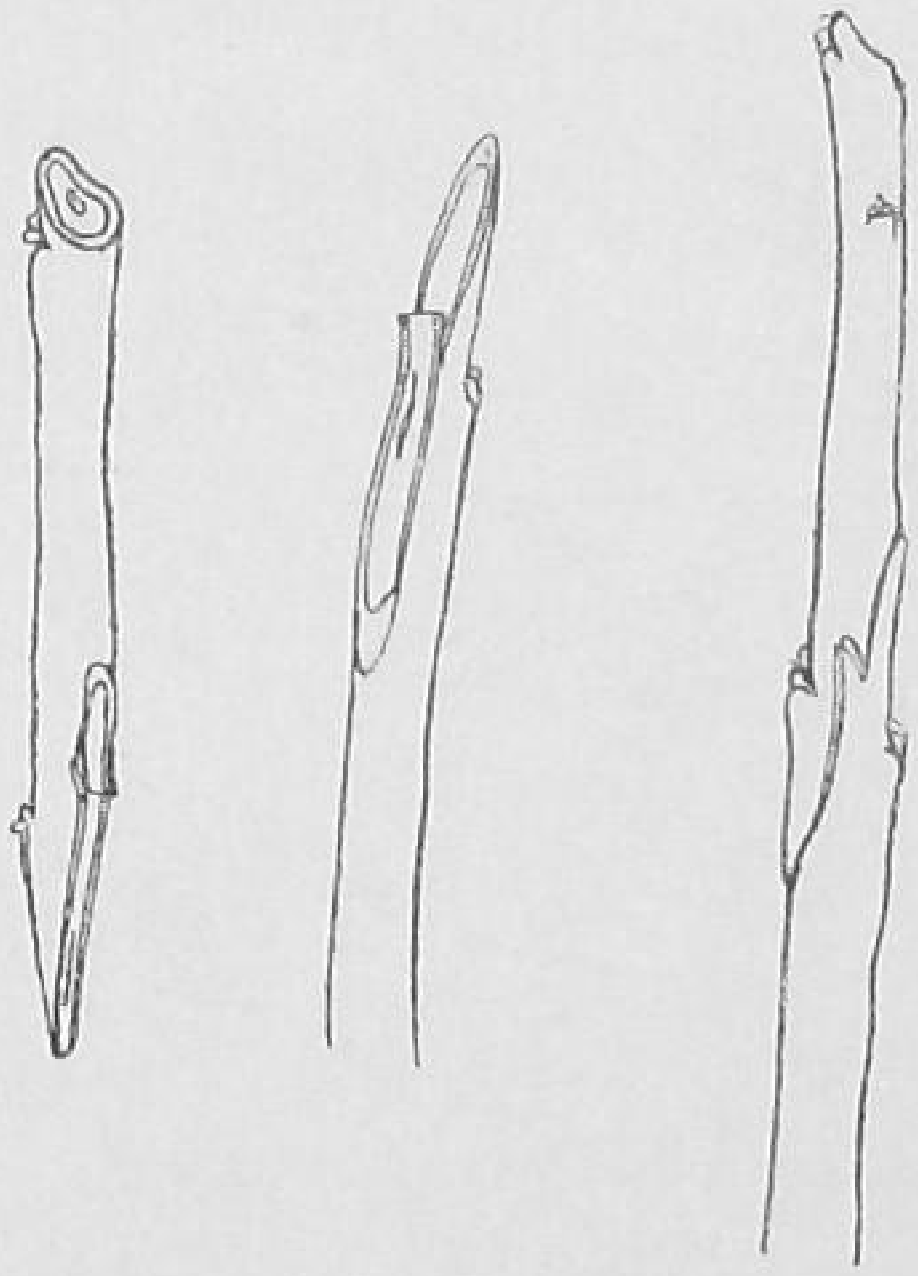
Instead of slicing off the rootstock and stem to have an evenly exposed surface, some prefer to make cuts in each in the form of a tongue in the middle of the exposed surface of the rootstock stem, so that through a corresponding cut in the scion stem, both the stems are made to fit each other securely by the protruding tongue of one inserted within the gaping cleft of the other.

Inarching is generally a tedious operation and can be expensive when the plants in pots to be used as rootstock have to be placed above the ground over a platform or tied or clamped to a post or to a branch so as to be close to the selected scion shoots. In such cases daily watering of the potted plants till the separation of the graft becomes necessary. If, however, the scion shoots are available close to the ground, the potted plants which serve as rootstocks can be placed on the ground and watered carefully.

8. *Side grafting:* In this the scion shoots are selected at a time when they are dormant or not in active growth. In the latter case all the leaves up to about four inches from the terminal bud are removed leaving about half an inch of the leaf stalk. About a week later, these shoots are cut off and two slanting cuts are made at the base, one being slightly longer than the other, to form a wedge shape. On the plant to be used as a rootstock, a cut is given on the side of the stem to form a cleft of the size where the wedges of the scion shoot can be fitted in, with the longer side of the wedge in contact with the stem. After the insertion of the wedge, the portion is firmly wrapped over with fibre or raffia strands. After the inserted shoot produces about two inches of new growth as a result of the union, the rootstock stem above the point of union is cut off and the graft becomes ready to be planted after some more growth is produced during a season.

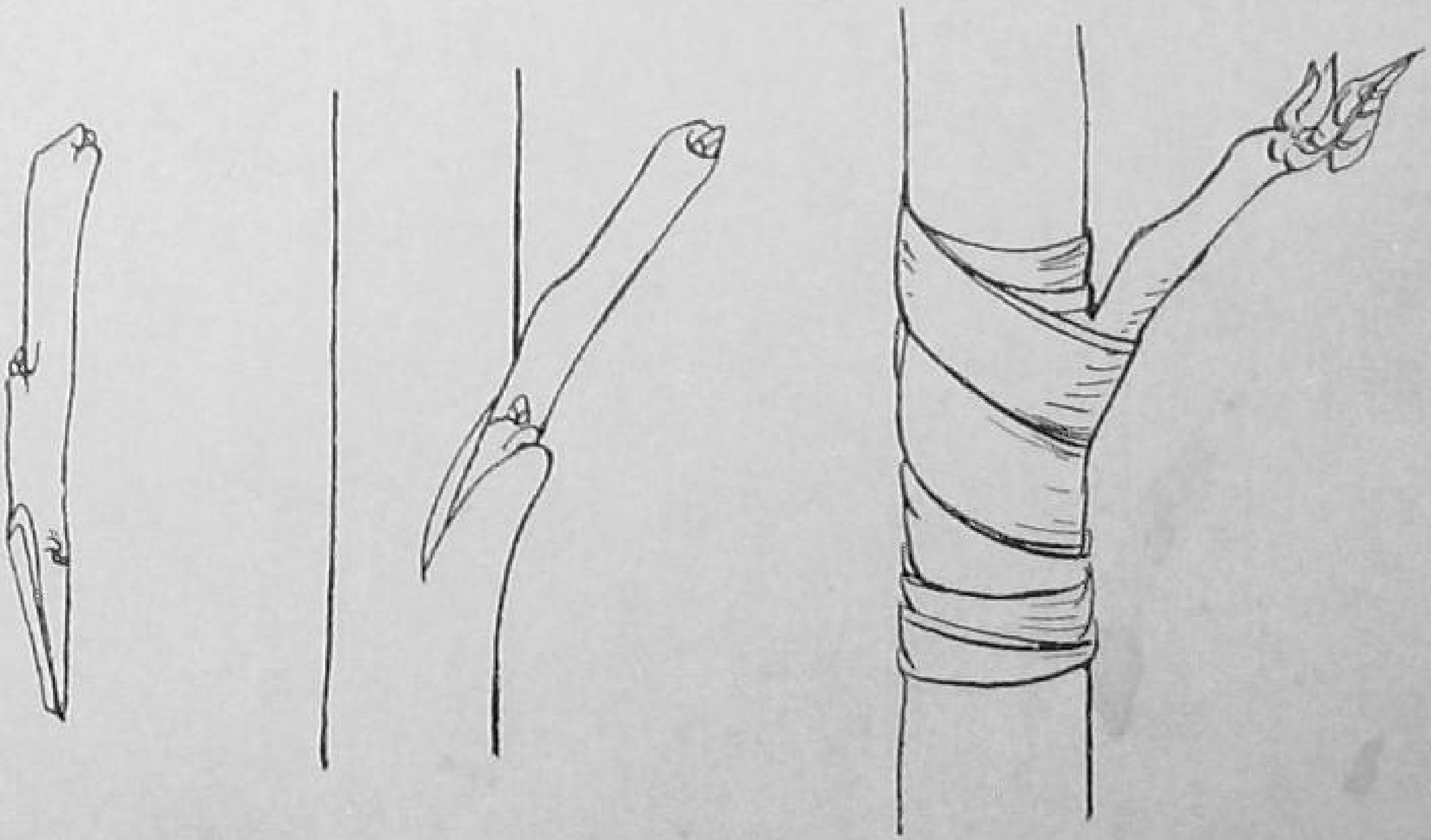
Inarching

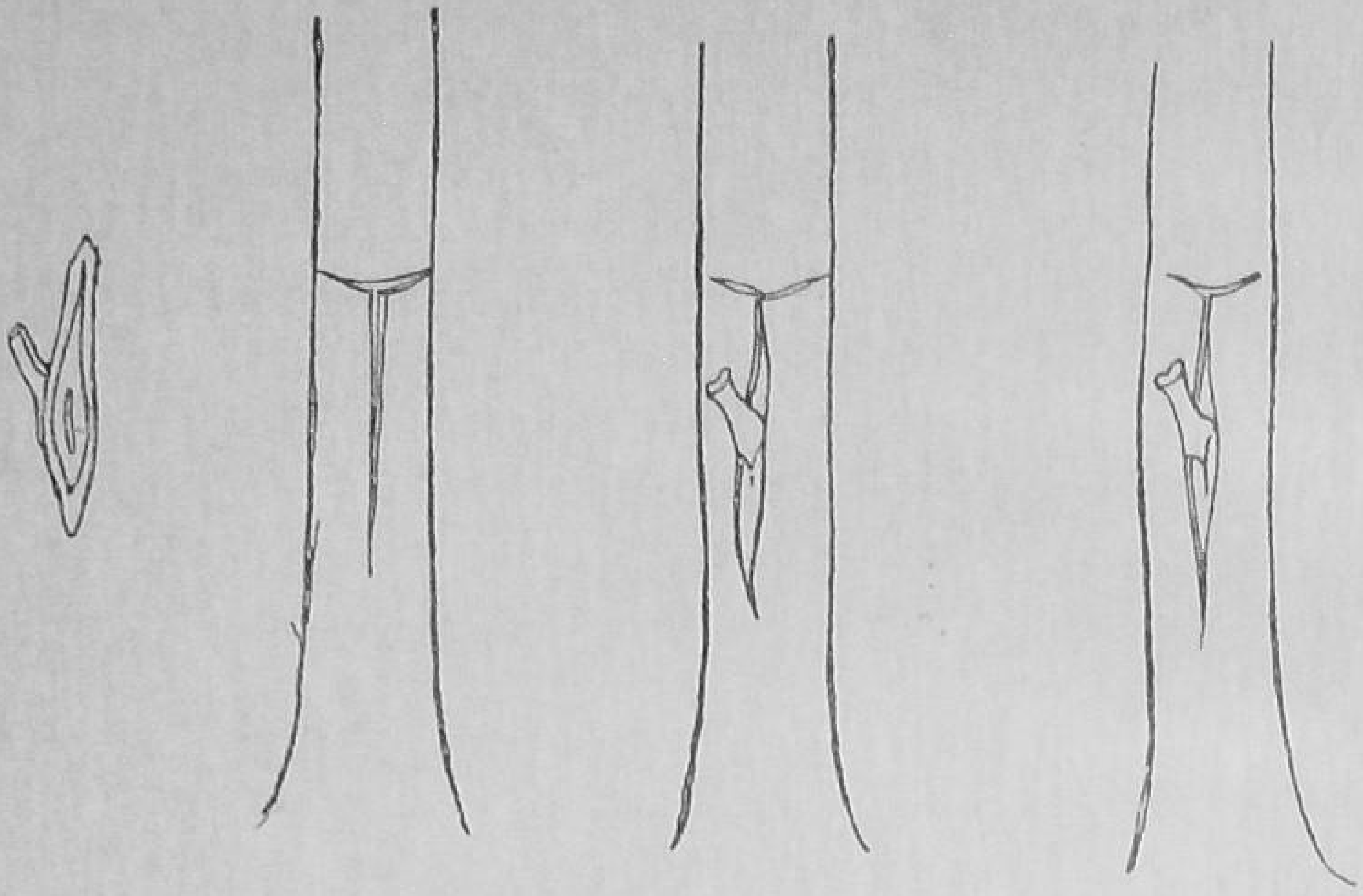




Whip and tongue grafting

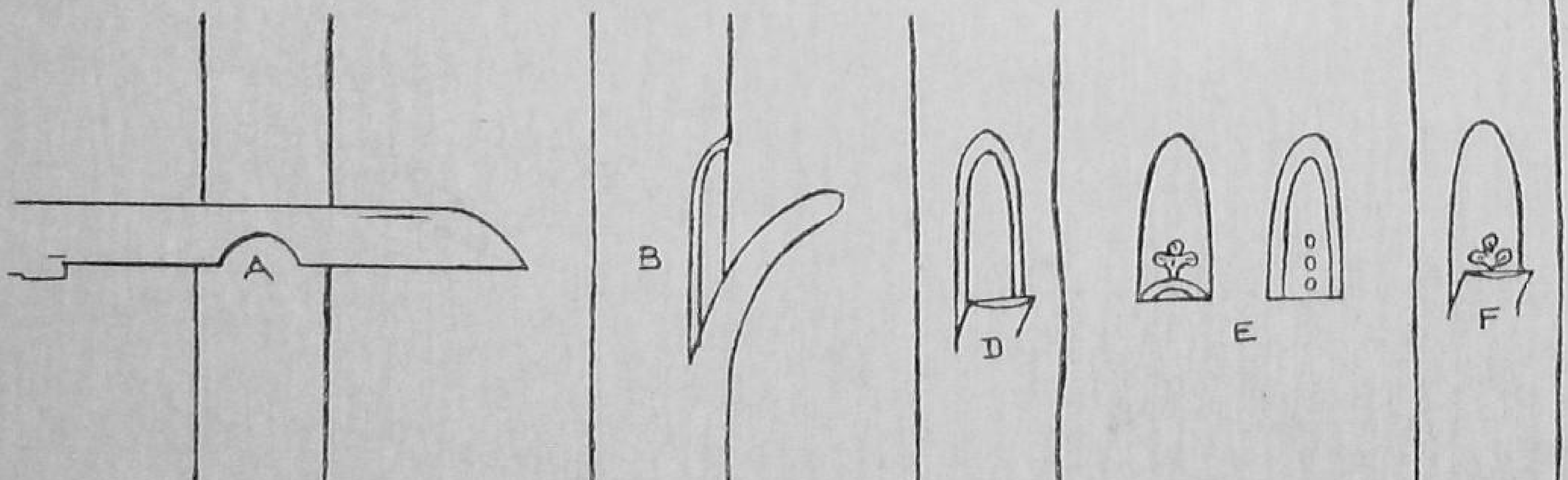
Side grafting





Shield budding

Flat budding



9. *Saddle grafting:* When the stem to be used as rootstock is cut transversely and is moulded to a wedge shape and the scion shoot is fitted over the wedge with a cleft prepared at the base and the region wrapped over, the method is known as saddle grafting. In this method, which is practised with apples in South India, the grafting region is also covered over with a mud poultice or grafting wax.

10. *Whip grafting:* Apple is also raised by whip grafting in the Nilgiris. In this the scion shoot is given a slanting cut two to three inches long at the base and a corresponding cut is made on the plant to be used as rootstock. The cut portions are then fitted together and bound over and sometimes sealed with grafting wax also. As in inarching, a tongue can also be made on the exposed surfaces, in which case the method goes by the name of whip and tongue grafting.

11. *Cleft grafting:* This is rarely practised in South India. It resembles the saddle grafting, except that in this case the cleft is made on the plant to be used as rootstock and the wedge is made with the scion.

12. *Shield budding:* All budding is a form of grafting in which only one or a few buds instead of a shoot is used from the scion to produce the new plant. Of all the methods of budding, shield method is the most popular. In this a bud with a piece of wood, shield shaped or rectangular, is taken from the selected scion shoot and is fitted into the rootstock stem through a slit. The slit may be a straight or may be supplemented by another to form a T or inverted T (⊥) shaped cut. The bud is inserted usually at a height of 9 to 12 inches above the ground level. After the insertion of the bud, the region is bandaged firmly with wax cloth strips or raffia fibre or similar material. When the bud grows to about two to six inches the rootstock stem above the point of bud-insertion is lopped off in one or more stages.

13. *Flute budding:* In some plants like mulberry, it is possible to remove the bud with a piece of bark in the form of a flute or ring or tube. To enable this to be done, two parallel cuts are made generally one to two inches from each other, completely encircling the stem shoot, in the

centre of which is a dormant bud. The bark with the bud within the two cuts is pulled out gently after peeling off the bark above the upper cut. The fluted bud is then inserted over the peeled portion of the rootstock stem till it fits well. When the scion bud has produced some new growth, the rootstock stem is lopped off just above the bud sprout.

14. *Flap budding:* In this the bark is peeled to a width of one third or one half of the rootstock circumference and to a length of one to one and half inches. The bud shield is then pushed under the flap to secure perfect contact. The flap is then brought into position and then wrapped around. After about two months the bandage is removed and the overlapping flap is cut off. After the bud-sprout is two to three inches long, the rootstock stem alone is lopped off. When the bud-shield is fitted without the overlapping flap, it is called patch budding.

15. *Yema budding:* This is not a popular method but is found possible in some trees where peeling of the bark is difficult. Here the bud is removed with a piece of stem adhering to it.

Scion Selection: A graft or a budded plant will be similar to the mother tree or the scion parent, subject to the modifying influences of the environment and rootstock. Thus, a Neelum mango graft will produce only Neelum fruits and may be affected by some of the same diseases as were found on the scion tree. Selection of a productive, healthy tree is important if the grafts or budded trees are to yield satisfactory crops. Some of the trees may produce inferior fruits on some parts of the tree due to mutation or sporting habit, in which case a careful search for scion shoots has to be made during the cropping season and the best scion shoots marked out and tagged.

Rootstock Selection: Many trees can be budded or grafted on several rootstock varieties, but not all these will produce the most satisfactory performers. For instance, Sathgudi orange when budded on wood apple produces very dwarf and short-lived trees, though with fruits of good quality, while on rough lemon, acid lime and sour orange

the same scion has been found to have very satisfactory growth and cropping in some places. Certain apples are affected by woolly aphis on some rootstocks, but on certain Merton rootstocks they are free from this pest. Rootstocks influence the scion performance in many other ways also, such as in the form or shape or size of the tree, in hardiness, disease resistance, yield, early or late bearing, tree vigour, quality of fruit, etc. A proper selection of rootstock is, therefore, of very great importance to successful fruit growing.

NURSERIES: Nurseries specialising in plant production are found all over the country, but all these may not be reliable or be able to supply plants most suitable for every situation and purpose. Selection of a reliable nursery to supply the best variety on the optimum rootstock is a prerequisite of good orcharding. If the grower himself has to raise the trees required by him, he must undergo a full course of practical training in all the operations which have been found most suitable for each fruit.

It is possible to sow seeds in pots or directly in the soil. In the latter case, it is necessary to prepare raised seed beds in the open using open textured soil, which permits free drainage, and to which well rotted cattle manure or compost is added in liberal quantities. When the seedlings in the seed beds have grown to a few inches, they are transplanted to nursery beds, which are larger flat beds also prepared in open textured soil for facilitating good drainage. Similar beds are also used for raising cuttings.

A pot yard is usually a place where some shade is available or can be provided, when necessary. Pots of different sizes are used according to the plants, but in all these it is necessary to provide one or more holes at the bottom for drainage. Over this crocks or broken pot pieces are placed, placing first a concave piece over the drainage hole. Bamboo pots or chip baskets are also used instead of earthen pots, while in the West Coast hill grass or coconut husk or coir containers are also common.

Hand forks are very useful for weeding seed beds and nursery beds. For watering young plants in seed beds or

pots small cans fitted with a fine sprinkling arrangement are essential, but later when the plants are planted in nursery beds water is applied either in flat beds by flow irrigation or through furrows between alternate plant rows. When the spacing is wide enough, *mamutti* digging or working of Planet Junior Hand Hoe are good for removing weeds or giving a light tilling to the soil. Organic manures, like well-rotted cattle manure or compost, are preferred in seed and nursery beds over quickly available nitrogenous fertilizers like ammonium sulphate, as plants forced to put forth active growth usually suffer more while being shifted from one site to another.

Chapter IV

LAYOUT OF ORCHARDS AND PLANTING

After the selected site is cleared of all vegetation, levelled or terraced as the case may be, the land has to be ploughed repeatedly and should, if possible, be sown to a leguminous crop like sunnhemp, indigo, *pillipesara*, cowpea, *daincha*, etc. This helps to improve the organic content of the soil and also to indicate any bad spots, which should be avoided for fruit tree planting. The plan of the proposed orchard is then prepared, showing the area assigned to each fruit and marking the tree rows. In preparing the plan, effort should be made not only to secure an orchard which would be attractive, but also ensure convenience and economy in management. Planting of trees of shorter stature in front, with the taller and more spreading trees behind, helps in better watching of the orchard. Fruits which ripen at the same time are better allotted contiguous areas. The trees that require irrigation should be near the irrigation source and the more fertile sections of the site should be devoted to more paying and heavy feeding trees. Raising of wind-break belts and thick live-hedges is essential not only for safety from pilfering and reducing damage from gales or high winds but also on aesthetic grounds. Roads are necessary for transport of orchard produce and manure, but these should not encroach on the space reserved for trees. It is advisable to seek the assistance of an experienced person for designing an orchard, which is a long-term venture and, therefore, any errors which creep in at the time of its planning cannot easily be rectified later.

Several systems of planting fruit trees are in vogue. Of these, the square system in which all trees are set out at right angles to each other is the most popular. This permits the raising of filler trees in the alleys and the filler trees which crop earlier can be removed before they compete seriously

with the main fruit trees for soil moisture and nutrients. The quincunx method is another, whereby the fifth tree set in the centre of the square made by every four trees is also a long lived tree. In this the fifth tree can be removed, if necessary, after some years of cropping to permit more scope for the remaining trees to grow. The hexagonal method is yet another system, whereby the trees are equidistant from each other, six trees enclosing a seventh one. With a spacing of 10 ft the square system gives 435 trees to the acre, while the quincunx and hexagonal will enable the planting of 870 and 500 trees respectively. All these methods of layout are possible on level ground, but on slopes, except on terraces, the planting of trees is best done along the contours.

Hedges and wind breaks: Many kinds of plants are employed to raise hedges in the southern part of the country such as *Prosopis juliflora*, *Thevetia nerifolia*, *Casuarina equisetifolia*, tamarind, *Agave sisalana*, *Inga dulcis*, pomegranate, etc. All these, as well as the wind-break belt, are preferably raised a couple of years before the fruit trees are planted. For the wind-break belt, quick-growing trees are preferred, unless this is established a couple of years ahead of the fruit tree planting. Seedling mango, cashewnut, *Pterocarpus santalinus*, *Millingtonia hortensis*, *Erythrina indica*, *Casuarina equisetifolia* are some of the more common wind breaks on the plains, while on the hills *Gravellia robusta* and blue gum are popular.

Drains: Fruit trees have to be protected from prolonged stagnation of water or excess of moisture in their root zone. Open or concealed drains, packed with boulders or gravel, are necessary to remove surplus water from all spots where this is likely. A few open drains can be laid on the sides of the roads to carry excess water.

Digging of holes for fruit trees: A wooden plank, about three feet long and three to six inches wide, with a notch in the centre and two notches on either ends is helpful to locate the exact spot for every fruit tree. When the actual tree position is peg marked, this plank is brought into use and two pegs are driven into the soil at the notches on either

ends of the plank. After this is done, the central peg which marks the tree position can be removed and digging of the hole can be begun. For most of the trees, a three feet cube pit is dug, though in good loamy soils even a two feet cube pit may be adequate. After the pit is filled, the wooden plank is again brought into use and the fruit tree is placed in the central notch and planted. The planting is done by refilling the pit with soil all around the tree, pressing the soil firmly but without injuring the earth ball around the roots. This ball of earth should remain intact, which is possible only if care is taken at the time of depotting it or digging it from the nursery beds till the planting operation is completed. Evergreen trees cannot stand exposed root systems for long and the retention of a ball of earth of about 3″ to 12″ diameter is necessary. When the plant is grown in a pot, the depotting is done by gently tapping the edge of the pot with the plant turned upside down, against a stone or hard substance, while keeping one hand pressed against the soil around the plant. If the plant is in the nursery, the lifting out of the plant is done by slowly digging around the plant about 3″ to 12″ away from the stem till the plant with a ball of earth can be taken out intact. Such balled plants have to be wrapped around their earth ball with gunny, grass or similar material to preserve the ball intact. Just before setting such plants in the planting hole, the wrapping material has to be carefully removed. Immediately the soil is pressed around the tree in its orchard site in such a manner as to enable it to stand at the same depth as in the pot or the nursery and water is let into the field to soak the soil around the plant fully, but not to stagnate. A basin of roughly two to three feet radius is prepared for this purpose, with the soil surface inside the basin gently sloping away from the stem of the fruit tree, so that when the basin is full, the water just reaches the level of the collar (junction of the root and the stem) while its depth at the farther end of the basin may be 2 to 4 inches.

PLANTING DISTANCE: When trees are planted close together the roots of neighbouring trees become crowded,

and there is a competition for plant food and moisture. There is also a competition for light in full grown plantations. Under shade, the growth and development of fruits are sometimes retarded and in some areas they also fail to develop colour and quality. The optimum spacing for trees depends on the size the tree attains ultimately, which depends on its turn on the variety, rootstock, environment and care. The common spacing that can be adopted is given under each fruit.

Selection of varieties: For economic fruit growing, it is essential to choose only such fruits as have proved their adaptability to the area or region and have given evidence of having performed well under similar conditions. It is a safe procedure to choose varieties which are being grown with success in the locality and to raise plants from trees which are well-known to yield good crops of the desired quality.

Age of tree for planting: It is not safe to plant old or overgrown plants, as these do not always travel well or stand transplanting. Generally speaking, trees are best transplanted within a year of grafting or budding.

CHAPTER V

ORCHARD CULTURE

IRRIGATION: Timely application of water in adequate quantities is as important for the success of irrigated orchards as of other cultivated crops. Even in rain-fed groves, irrigation may be important soon after planting and occasionally when they show distress due to prolonged drought. The irrigation requirements depend on many factors such as the kind of fruit, variety, rootstock, climate including rainfall, soil, spacing, soil culture, the intercrops grown in the orchard and the training and pruning methods used. No definite procedure can, therefore, be laid for general adoption. The general advice that is given is to apply water only when the first 12 inches of soil have gone dry and each time ensure the soaking of as large a part of the roots area as possible. A rough soil test is usually carried out to determine when to apply water, and this consists of examining the soil up to 12 inches depth in half-a-dozen different places in an orchard. If the soil is dry and crumbles when pressed, application of water is considered necessary. The roots of a tree usually spread a few feet beyond the spread of its branches, and, therefore, there is need to apply water up to or a little beyond the drip of leaves. Since there are only a few feeding roots near the trunk, water need not be applied close to the trunk.

There are several methods of irrigation, of which the flooding is possible only on flat ground and when water supply is plentiful. It also leads to an excess of weed growth. The check or bed system, wherein the water is applied in small beds formed between the trees, suffers from the same defects as flooding, though to a lesser extent. The basin system is suitable for level and slopy ground, but it is useful only if the basin is prepared in a way to cover the major feeding zone and with a gentle slope away from the tree trunk to prevent water standing in contact with the trunk for

long periods. The furrow system prevents saturation of the entire soil and reduces cultivation and is, therefore, economical in the use of water. But it is possible only in medium and heavy soils, provided the furrows are small and not too many and the water movement is slow to enable adequate spread of moisture in the root zone. Generally the furrow is between 200 ft to 400 ft long and the number of furrows between any two rows of trees in an orchard with trees spaced 20 ft apart, may be four to five. This system is not practised by any large body of growers in India.

The quality of water is of great importance and that containing above 400 parts of total soluble salts per million should be used only after being certified as safe by a competent chemist.

Soil culture: Grove culture is done to prepare the soil for the cultivation of intercrops or the raising of green manures, the incorporation of manures or fertilizers, the preparation of soil to receive moisture and to destroy weeds and pests. Soil culture also facilitates the circulation of air in the soil and provides adequate quantities of oxygen for nitrification, the process by which the nitrogen contained in the organic material in the soil is made available to the tree roots.

Since the roots spread within a few inches of the soil surface, deep tillage may lead to serious injury. This does not detract from the value of occasional shallow soil culture, such as can be given with hand tools, or with implements like the Planet Junior Hand Hoe, to prevent cracking of the soil and for scraping off weeds before they send down deep roots. On the sloping land, soil stirring may aggravate soil washing, and a permanent vegetative cover outside the tree basins is, therefore, recommended. Mulching the basins with crop residues or grass is also possible to protect the land on such soils against soil erosion during the rains. Mulched soil basins have been found specially beneficial for mandarin oranges in Wynaad. Under such conditions, it is necessary to safeguard against risks of fire or pests, which may harbour under the mulch. Generally speaking, the main

or deep ploughing or digging operations are better practised before the fruit trees are planted, so that all deep rooted weeds and shrubs are removed. After planting, deep ploughing may continue for some years in orchards to facilitate the incorporation of green manures or to raise intercrops, provided the ploughing is done in areas not covered by tree roots. In subsequent years, shallow soil tilth is possible in seasons when the trees are relatively dormant, such as just before flowering and at the time of incorporation of manures and to enable the reformation of tree basins and furrows for irrigation. October to December is the usual period for all such tillage operations. When tillage is done with bullock power, injury to trees should be avoided by providing light cages around the fruit trees, which can be shifted from row to row as the ploughing or hoeing operations proceed.

INTERCROPS: The growing of intercrops is usually done during the pre-bearing stage of fruit trees, to provide an additional source of income from the land. Tall growing crops are not advisable, lest they shade the fruit trees. Vegetables can be grown, provided they are restricted to the alleys not foraged by the tree roots. Paddy or sugarcane are not recommended to be grown in an orchard, as they require plenty of water and this may be harmful to fruit trees. Adequate manuring of the intercrops is necessary, lest they compete with fruit trees, to the detriment of the latter. All intercrops should be deemed as secondary crops to the fruits and be treated as such. Cover crops like *Calopogonium muconoides* and *Centrosema pubescens* are useful in orchards on sloping land, as they protect the soil against soil erosion and prevent weeds from gaining the upper hand.

MANURING: Fruit trees cannot grow or prosper on soils which are highly acidic (below 4 pH) or very alkaline (above 9 pH). They demand the supply of many chemical elements for proper growth and cropping, some of which are considered essential and have to be supplied or be present in the soil in large quantities, while others are required only in very small quantities. The plant foods most

commonly leached in soils are nitrogen, phosphorus and potassium and it is these that are commonly applied as manures. Recently it has come to be known that certain minor elements are also essential to ensure healthy growth and optimum cropping and among these are zinc, copper, iron, magnesium, manganese, etc., though the absence of one or more of these is felt only in some soils and with some crops.

The exact requirements of manures for each kind of fruit and on each of the different soils have not yet been fully worked out under Indian conditions. However, on the basis of soil analyses and experience of the local conditions, the Officers of the Agricultural Departments are in a position to suggest broad outlines of the manurial practices. But each grower can obtain more accurate indications through the conduct of some simple manurial trials in his own orchard. These may be very rough trials, wherein each tree row is put under one manurial treatment and two to five such treatments may be under test, consecutively for a period of five years. At the end of this period, the grower can easily judge the best treatment by merely noting the health, vigour and yielding capacity of the trees under each treatment.

The common names of fertilisers used in orchards with their usual dosage are given below.

1. Nitrate of soda	..	350 lb per acre
2. Ammonium sulphate	..	300 lb ,,
3. Superphosphate (single)	..	300 lb ,,
4. Sulphate of potash	..	300 lb ,,
5. Cattle manure or compost	..	25,000 lb ,,
6. Oil cake (groundnut)	..	4,000 lb ,,

Most growers use organic manure and supplement it with ammonium sulphate, using half of the dosage of each of these. Organic manure can decay rapidly and fully only when ample watering of the soil is done regularly. Watering the soil immediately after the application of all manures is also necessary to dissolve them and carry them to the root zone. Application of manure in lumps or in large quantities close to the roots is injurious to the plant. It should be

evenly distributed and well incorporated into the soil. Occasional green manuring of the orchard is desirable to improve the physical, bacteriological and manurial status of the soil. Green manure crops should be preferably leguminous and should be grown during rainy seasons and incorporated into the soil just before the flowering stage, when the rains are likely to make adequate soil moisture available for their decomposition.

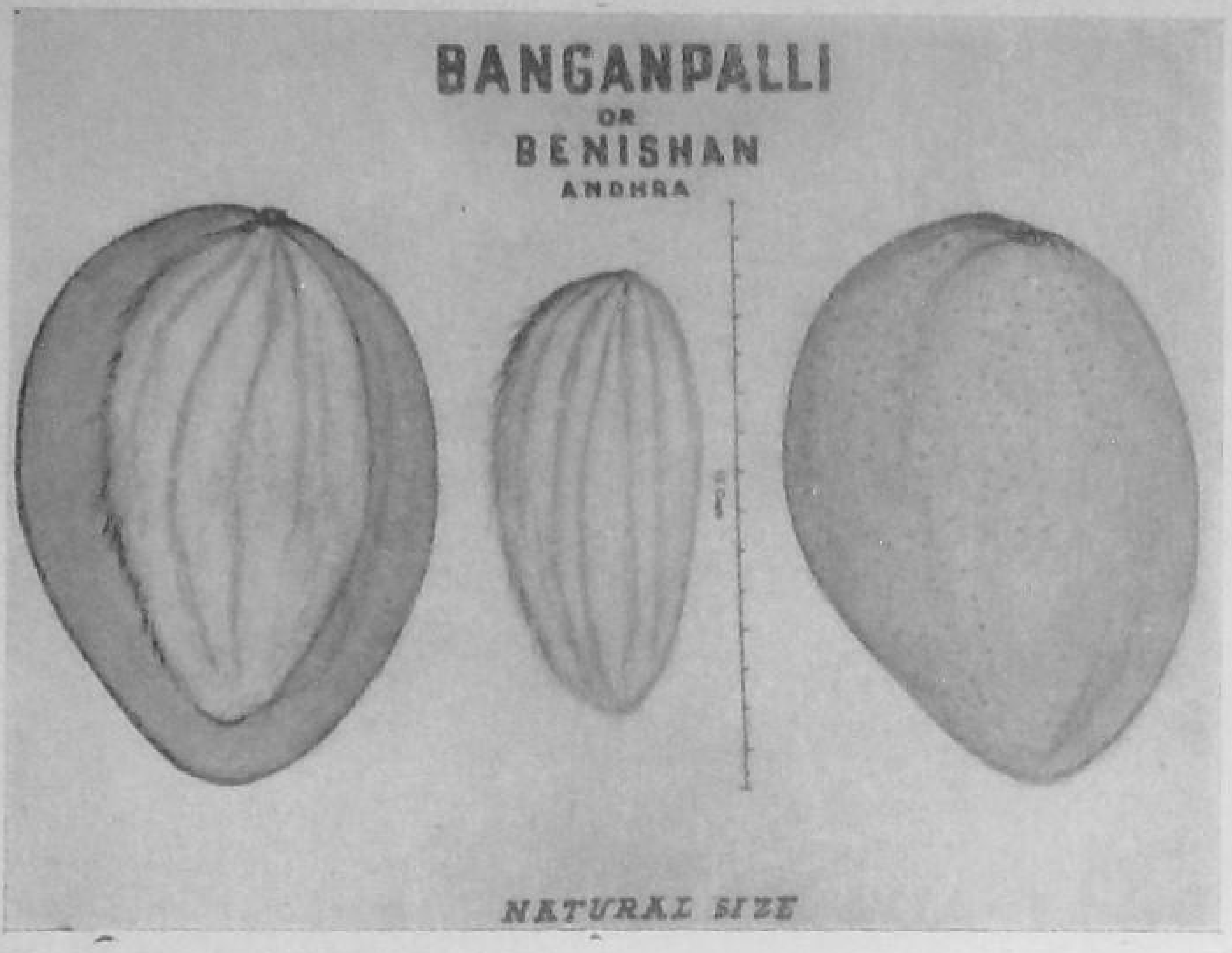
Training and pruning: The training of a tree is done to secure a proper framework, while pruning is done not only to build the framework but also to induce the tree to maintain a balance between growth and production of fruit. Every tree has its characteristic growth and fruiting habits and the training and pruning methods must be designed in conformity with the tree's requirements. A mango tree, for instance, produces its crop on the terminal shoots; grape produces on the new shoots which arise on the past season's growth, jack fruit produces fruits on the trunks or main limbs; the apple on either spurs or terminal growths. A standard method of training or pruning for all fruits is not, therefore, possible. Moreover, some trees fruit heavily in one year and this depresses their fruiting capacity in the succeeding year. Pruning helps in regulating the crop size without detriment to the tree health. An efficient tree is an ideal combination of a few strong dominating limbs with numerous secondary growths. Too many trunks or main limbs lead to a weak framework. To regulate the tree shape in conformity with the shape characteristic of the variety and to regulate growth to yield a succession of good crops, is the aim of any intelligent training and pruning programme.

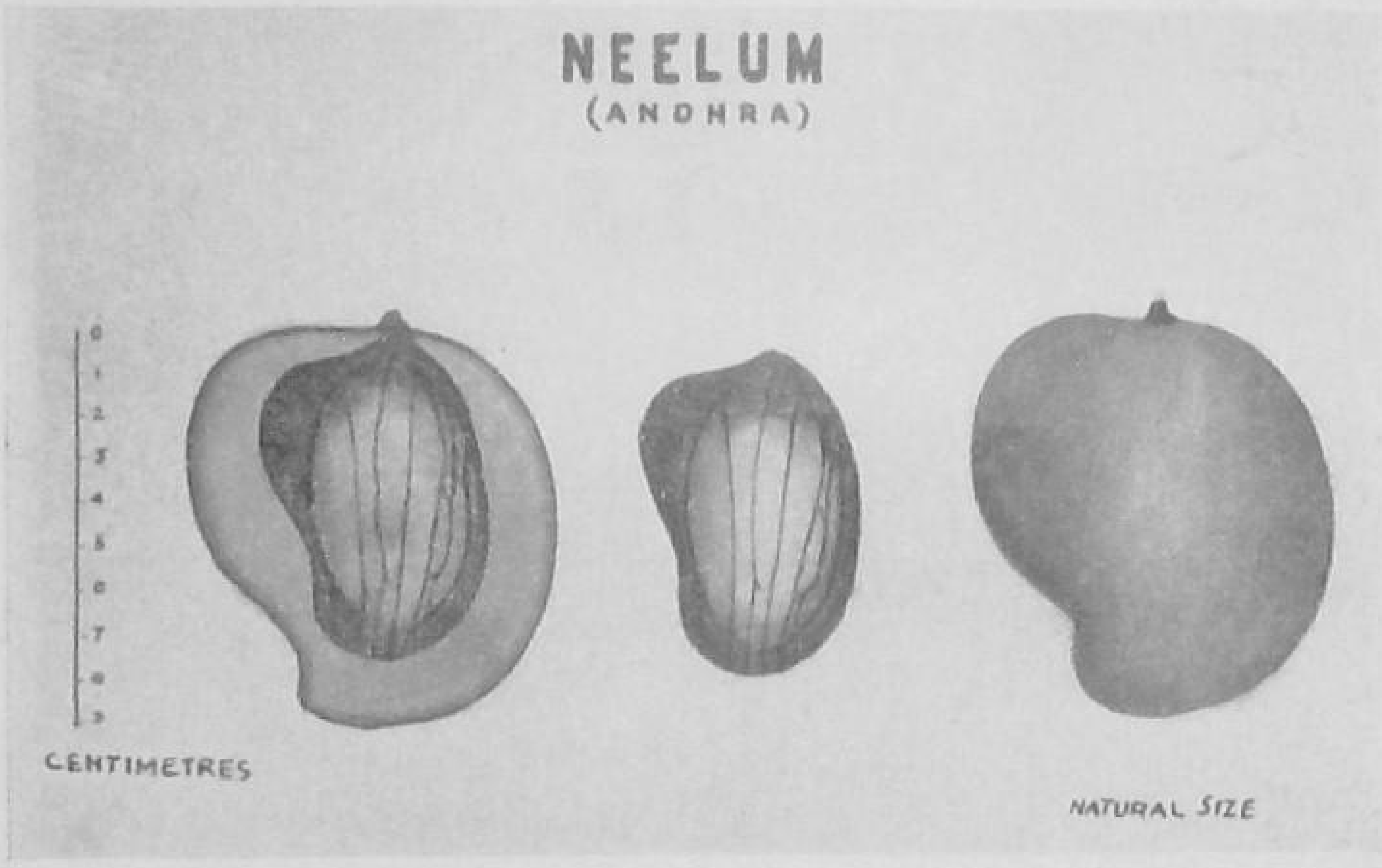
The training of the tree is done from the time the plant is raised in the nursery. In deciduous fruits, like the apple, pear, plum or peach, the young plant is to be headed back, leaving a few well placed shoots all around the trunk and removing the rest. The grower has to decide at what height from the ground level the side shoots should emerge. Generally two feet is the height adopted, so that culture of the soil at the base is facilitated. After the scaffold limbs are

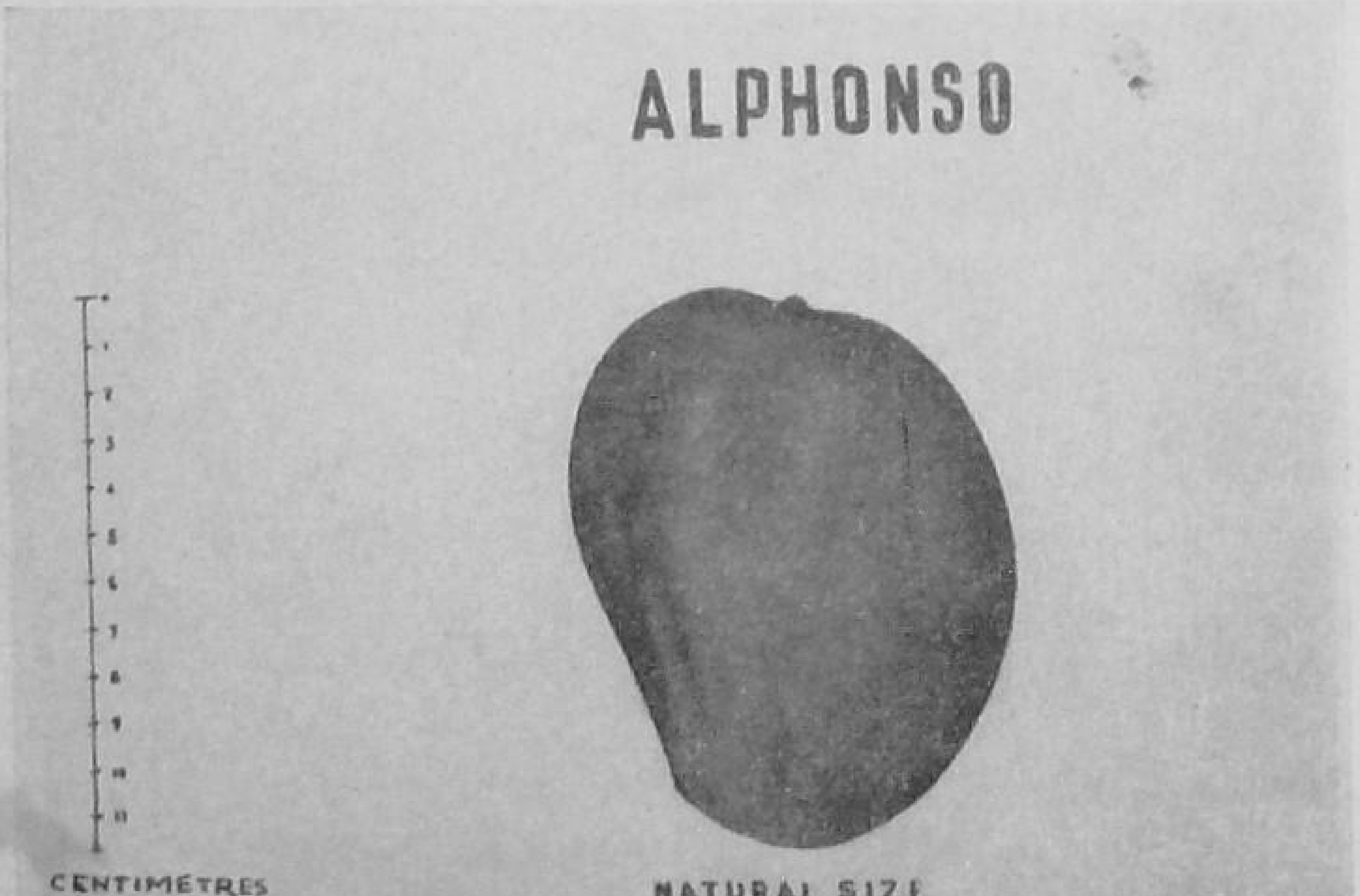
selected, their growth has to be watched to ensure that they grow to form an evenly spreading tree. To direct the course of branches, cutting of the branches to an outer or inner bud is done occasionally or annually, besides removal of all misplaced growths and thinning of congested parts. The pruning of a tree after it has developed the framework and to secure a crop of optimum size requires a good understanding of the bearing habits of each variety, as already indicated. This will be discussed under individual fruits in subsequent pages.

Basin method of irrigation

An unpruned mango tree—difficult for soil culture and with fruits liable to get damaged when close to the ground


BANGANPALLI
OR
BENISHAN
ANDHRA
NATURAL SIZE


NEELUM
(ANDHRA)
CENTIMETRES
NATURAL SIZE


ALPHONSO
CENTIMETRES
NATURAL SIZE

Chapter VI

IMPORTANT FRUITS AND THEIR CULTURE

1. Mango: This is one of the choicest fruits and claims the largest area among all the fruits grown in the country. Least exacting in soil conditions, it grows in most parts of South India up to an elevation of about 4,000 ft though it crops best on the plains. Thousands of varieties are known among which the following are the most important in South India.

(i) *Bangalora* also known as *Totapuri, Kilimukku* or *Collector* is an oblong fruit of medium to large size with fibreless flesh of medium quality producing regular and heavy crops of fruits of good keeping quality.

(ii) *Alampur Baneshan.* Medium to large, markedly long fruits with firm and fibreless flesh of fine eating quality ranked as one of the best in the country.

(iii) *Bennet Alphonso.* Medium sized fruit, fairly juicy and bearing early crops of good eating quality in the West Coast.

(iv) *Baneshan or Banganapalle.* Medium to large fruit with a slight turpentine flavour but yielding heavy crops and flourishing in most parts of South India. A very popular variety of good quality and of fibreless flesh.

(v) *Cherukurasam.* A large and oblong fruit with soft fibrous flesh, very juicy and of fine quality. One of the best among juicy mangoes.

(vi) *Himayuddin.* A large obliquely oval fruit with firm and fibreless flesh of very fine quality, but of rather shy bearing habit.

(vii) *Jahangir.* A large fruit, rather ovate, yielding poor crops but with fibreless fruits of very high quality.

(viii) *Alphonso* or *Khadar* or *Gundu* or *Badami.* A well known fruit, giving medium to heavy crops, of good keeping and fibreless quality, classed among the best of Indian mangoes.

(ix) *Olour.* A small to medium sized fruit, oval in shape, fairly juicy, appearing early in the market. Quality medium but bearing heavy.

(x) *Rumani.* Medium sized, roundish fruit with firm and fibreless flesh. A heavy bearer in mid and late seasons. Fruit is of medium quality.

(xi) *Mundappa.* Medium to large fruit, with firm and fibreless flesh and good eating quality. Bearing in mid or late season.

(xii) *Mulgoa.* Medium to large fruit, roundish oblique, with firm and fibreless flesh, of good eating quality. Bearing poor.

(xiii) *Neelum.* Small to medium in size, ovate oblique in shape, with fibreless flesh of medium to good eating quality. Bearing regular and heavy, being classed with Bangalora among the most dependable croppers.

(xiv) *Swarnarekha.* A medium sized fruit, ovate oblong, with soft and fibreless flesh of fair to good quality. Bearing early and heavy.

(xv) *Peter or Pairi or Raspuri.* Small to medium sized fruit, ovate in shape with firm and fibreless flesh, fairly juicy and good eating quality. Bearing heavy.

Some new varieties have been recently evolved by breeding and many new varieties spring up constantly in nature and the choicest of these are perpetuated by grafting.

Except some varieties like Olour which breed true from seed, grafting is the common method to multiply the choice varieties. Olour is able to produce more than one seedling per seed and all but one resemble the parent in such ploy-embryonic mangoes. Grafting by inarching is the most popular nursery practice, though side-grafting and budding by flap method have been found to be equally successful. Seeds of healthy, heavy-yielding, country or polyembryonic mangoes are sown to raise the seedlings in beds with a spacing of about 9 inches in the row and about 18 inches between the rows. The seedlings are transferred to pots with a ball of earth after five to six months. A year after sowing these are used for inarching to the selected scion parent. About four

months after grafting, the grafts are separated and one to three months thereafter they are fit for planting in the orchard. July to December is considered to be the best period for planting and the common spacing in the orchard varies about 40 ft from tree to tree. Except for watering immediately after planting and for a year or two during the dry spells, mango trees do not receive irrigation in most parts of South India nor are the mango orchards manured. However, in poorer soils occasional irrigation and annual manuring with well-rotted cattle manure or compost, are considered beneficial. Except for the renewal of dead and diseased wood and loranthus-infested branches, no pruning is done. Intercropping can be done up to about the eighth year of planting and occasional green manuring is also helpful. Most trees begin to yield fruit from the fifth year of planting, while a normal yield is expected from about the twelfth year. The harvest season extends from March to July, though a light off-season crop is sometimes borne all round the year. Erratic yields are the feature of many varieties, but an annual yield of 500 fruits is considered normal for a tree of about 15 years of age.

2. Citrus fruits: This group comprises of (1) sweet oranges including the Sathgudis and Batavians, (2) mandarin oranges including the Coorg and Kamala oranges, (3) lime, (4) lemon, (5) pummelo, (6) grapefruit, (7) citron, (8) sour oranges and some other types less known in this part of the country. The sweet oranges are at their best on the plains when grown in good loamy soil of great depth, supplied with irrigation and adequate manures. The loose jacket mandarin oranges thrive on higher elevations up to an altitude of about 5,000 ft, generally under rainfed conditions, though in recent times they have been found to suffer greatly in eroded soils and under neglected conditions. The lime is found best in the plains under irrigated conditions both in loamy and clay soils, but where atmospheric conditions are mainly dry, they yield larger crops of better quality. Lemons are found to flourish equally well on the plains as also at higher elevations up to 6,000 ft from the mean sea

level. The pummelo is found thriving under heavy rainfall conditions of the West Coast as well as at high elevations up to about 5,000 ft, while the grapefruit seems more adapted to the drier conditions of the plains. The citron and sour oranges are not commercially produced anywhere, but exist as stray trees all over the plains. A variety of rough lemon is also found as stray trees in all such situations.

Except for rough lemon, citron, pummelo and mandarin oranges, it is now seen that budded trees are becoming popular for raising all citrus fruits, though seedling orchards of these are still found in large numbers in all parts of South India. The seeds are sown in raised seed beds and the seedlings are transplanted to flat nursery beds, six to nine months after sowing, generally with a spacing of 9″ to 12″ in the row and 18″ to 24″ between the rows. Frequent irrigation is necessary both in seed and nursery beds. A year to 18 months after sowing, budding by shield method is done. Many rootstocks have been tried for different citrus and of these, the lime, sweet orange, sour orange and rough lemon have been found promising for Sathgudi, while lime, rough lemon and Gajanimma (a variety of citrus not edible and with fruits resembling a round citron) have been found suitable for lime. For seedling plantations, one to two year old seedlings can be planted. Lemons can also be raised by layering.

Selection of scion bud sticks has to be done with care in the case of citrus, as this group of fruits are prone to give rise to bud sports of usually inferior type in large numbers. It is, therefore, desirable to tag the shoots yielding choice fruits in large numbers during the fruiting season and take out buds only from such tagged shoots.

Rootstocks play a pronounced influence in the performance of citrus. Sathgudi budded on wood apple, for instance, has been found to produce very dwarf trees, which die in about 12 years, while the fruits produced on rough lemon and Gajanimma are found to be rather coarse and inferior in quality. From the point of disease resistance, yield and fruit quality, sweet orange and lime rootstocks are

perhaps the best for Sathgudi so far as is known at present. The seedling trees produce fruits two to four years later than the budded trees.

The spacing found desirable for sweet oranges on the plains is 27 ft to 30 ft for seedling and 22 ft to 25 ft for budded trees. For limes 25 ft to 30 ft spacing is necessary in fertile soils, but elsewhere even 15 ft to 20 ft is found adequate. Similar disparity is found in the case of other citrus.

Citrus fruits generally need intensive cultivation, except when grown under rainfed conditions. For Sathgudi orange, annual application of 20 lb of well-rotted farmyard manure, with four to five pounds of sulphate of ammonia and five to ten pounds of superphosphate is sometimes recommended for adult trees. Spraying with zinc sulphate-lime mixture (5 : 5 : 50) regularly has also been found useful where leaf mottling is common. Occasional green manuring, with intercropping during the first five years, is also being practised.

Too much pruning encourages sucker growths in citrus. Removal of old and diseased wood and thinning of congested areas are, however, necessary. In lime, the diseased and dead wood removal is specially important. The frequent removal of rootstock sprouts is another essential operation.

The sweet and mandarin oranges produce two crops a year with a third crop in some seasons, the first or main crop for Sathgudi being from November to March, the second from June to November, with the third from March to June. In mandarins, the crop is harvested from December to April for the main season and from July to September for the second, with a small third crop in September. Limes are in harvest almost throughout the year, while other citrus fruits are in season generally from August to December. An average yield of 1,000 fruits is common in well-kept Sathgudi and mandarin orchards while with limes the yield may range from 1,000 to 5,000 fruits per tree, pummeloes and grapefruits yield about 200 fruits per tree in a year.

3. BANANA: A very popular table fruit, the banana is also used for many other purposes. Fruits of some varieties are good for culinary use as also the 'heart' or the central core of the pseudostem. The leaves are used as dining plates, the fibre in floral trade, the leaf sheaths and leaves for wrapping and packing material. Banana grows up to about 5,500 ft height from the mean sea level and both under irrigated and rainfed conditions, the latter being a feature of the higher elevations and in some parts of the Tanjore district.

Of the nearly 100 varieties known in India, the following are among the most important in South India :—

(i) *Poovan*. Poovan is a dessert variety, growing tall and producing bunches with closely packed, medium sized fruits which are yellow when ripe and of good eating quality.

(ii) *Sirumalai*. Also a popular dessert variety, grown on elevations ranging from 3,500 to 5,000 ft on the Palni hills. The fruits are dusty yellow or greenish yellow, medium sized, angular and of good quality.

(iii) *Mauritius*. A dwarf variety producing large, greenish or greenish yellow fruits with sweet pulp. Also a popular table variety.

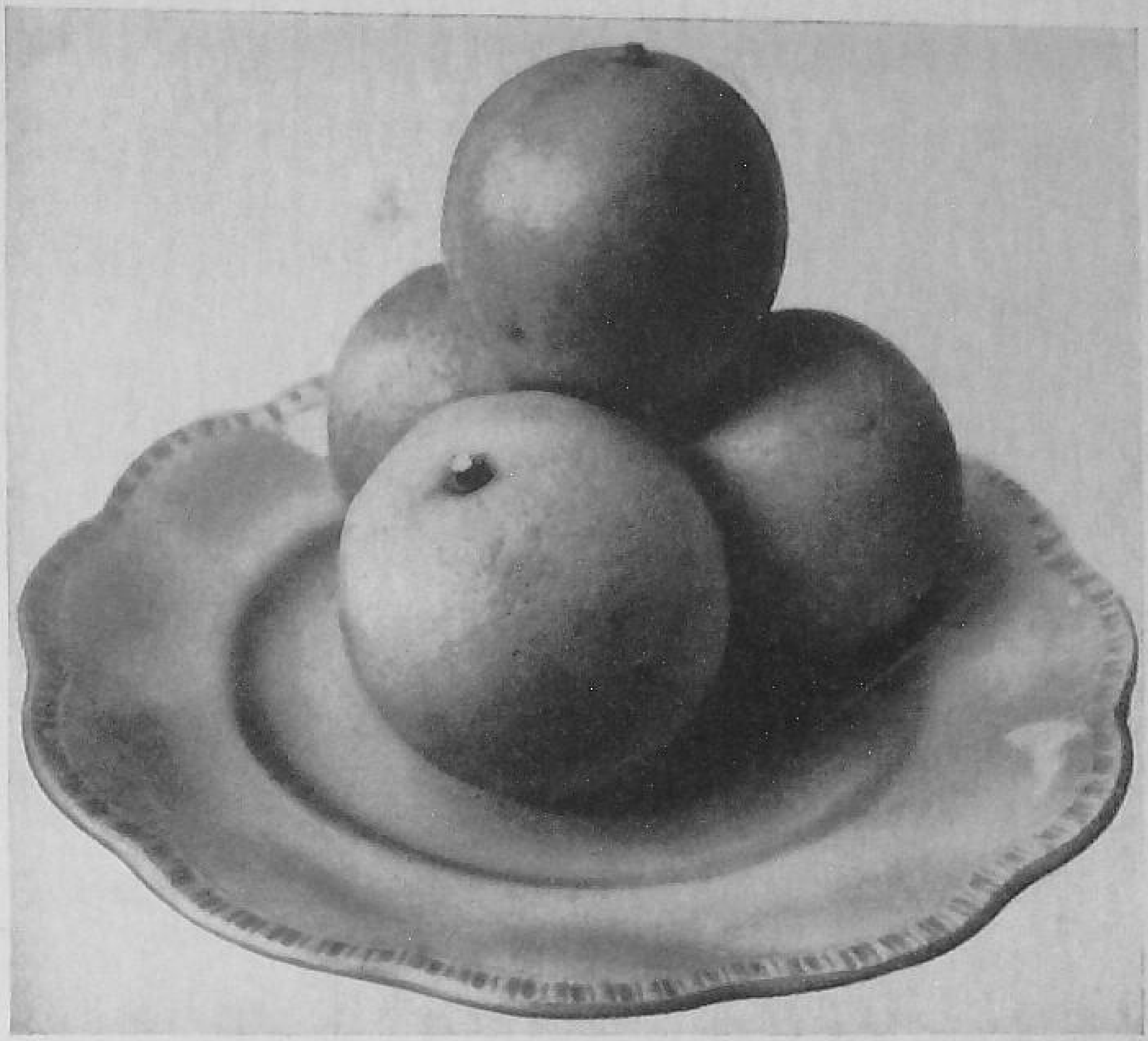
(iv) *Rastali*. Another popular table variety but with tall stems and with fruits resembling the Poovan in size and colour but having a dry and floury taste.

(v) *Chakrakeli*. This is a sweet fruited variety with rich flavour and prized as a table variety in the Circars. The pseudostem is about 9 ft high and the fruits are medium sized and yellow when ripe.

(vi) *Gros-Michel*. This is a famous commercial variety bearing fruits resembling the Mauritius but of a distinctly superior taste and flavour.

(vii) *Nendran*. This is a group of bananas widely cultivated in the West Coast and Travancore-Cochin State both for table and culinary purposes. The fruits are large, green to greenish yellow when ripe, angular and only of medium quality as table fruit.

(viii) *Monthan*. A popular culinary variety with large angular fruits.



Sathgudi orange fruits

Young banana plantation

Mauritius and
Nendran bananas

The propagation of all bananas is done commercially by suckers, which are removed from the mother plant when two or more feet high. Vigorous suckers with stout base and tapering towards the top and possessing small, narrow leaves are preferred to wide-leaved, weak or slender pseudostemmed plants. The sucker should have a piece of the rhizome attached to it with a few roots. Some prefer to cut back the pseudostem at a height of about 12 inches above the rhizome.

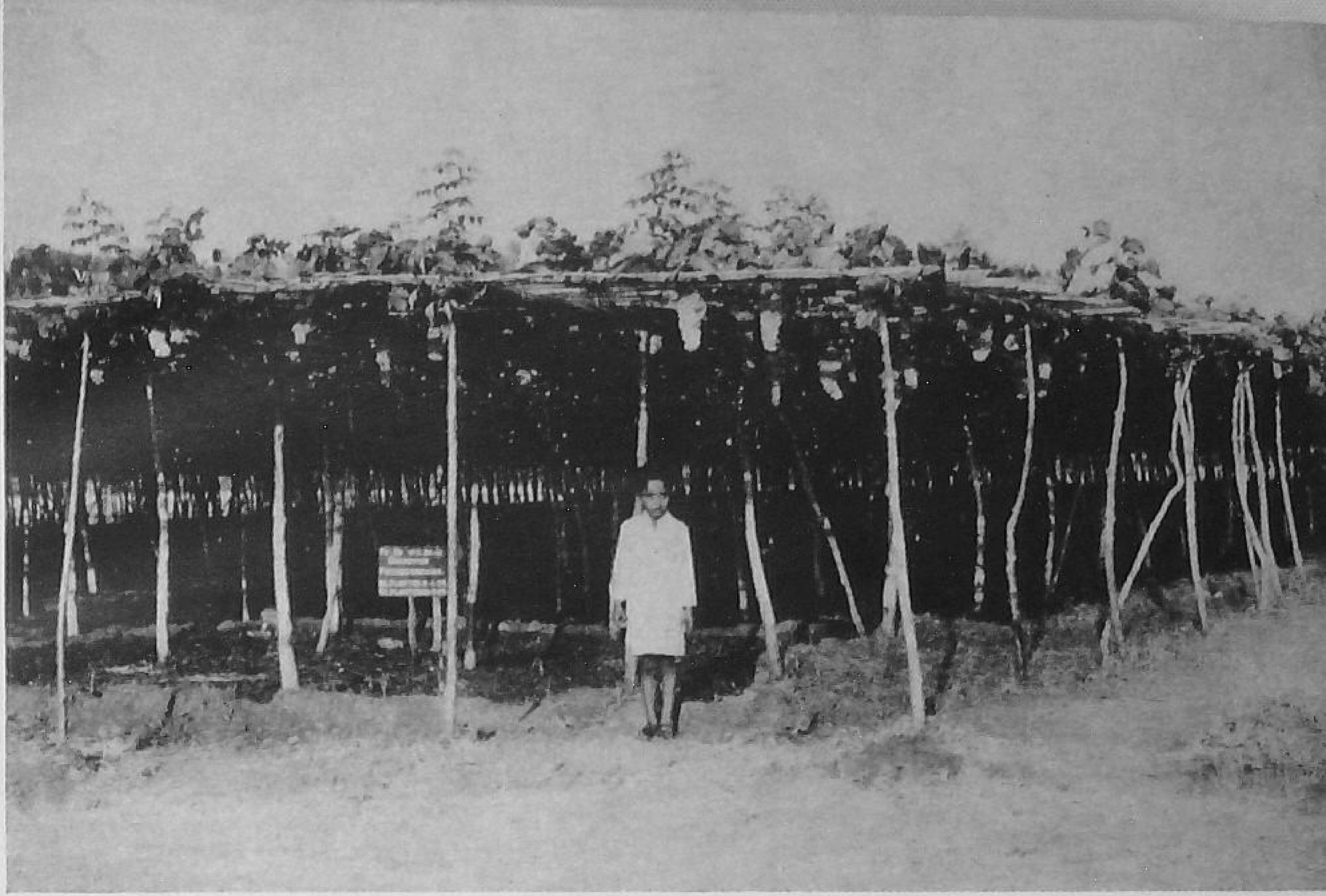
The suckers are usually planted in the rainy season, though it is not unusual to plant them during the rest of the year to get an off-season crop. They may be planted by themselves or interplanted in areca, mango, jack, coconut, coffee, mandarin orange, betel leaf or pepper plantations. In paddy lands, where the banana is raised as a rotation crop and in perennial plantation areas, suckers are sometimes planted without any preparatory soil culture.

Holes of about one foot cube are dug for planting the suckers and ditches or trenches are made for draining off surplus water. A dressing of cattle manure at the rate of 20 to 30 cartloads per acre is given at the time of or just before planting. Wood ash is also added at the same time in the West Coast. The spacing varies from 7 ft × 7 ft to 10 ft × 10 ft depending upon the variety and soil. Except under rainfed conditions, frequent irrigation is necessary. About four weeks after planting, cattle manure is applied in most places, while in wetlands sulphate of ammonia at 224 lb per acre is given by some growers. In about the sixth month of planting, the same dosage is repeated. In perennial banana lands only annual manure application is done with one to three baskets of cattle manure or village refuse, and the soil is also dug in and around the trees two to four times a year. Inter-cultivation of banana by bullock power is rarely done, *mamutty* digging being the common practice. Yams are sometimes raised as intercrops in the Kerala State. To avoid the damage by high winds, especially during the bunching period, propping is done with wooden or bamboo poles. The dwarf varieties like the

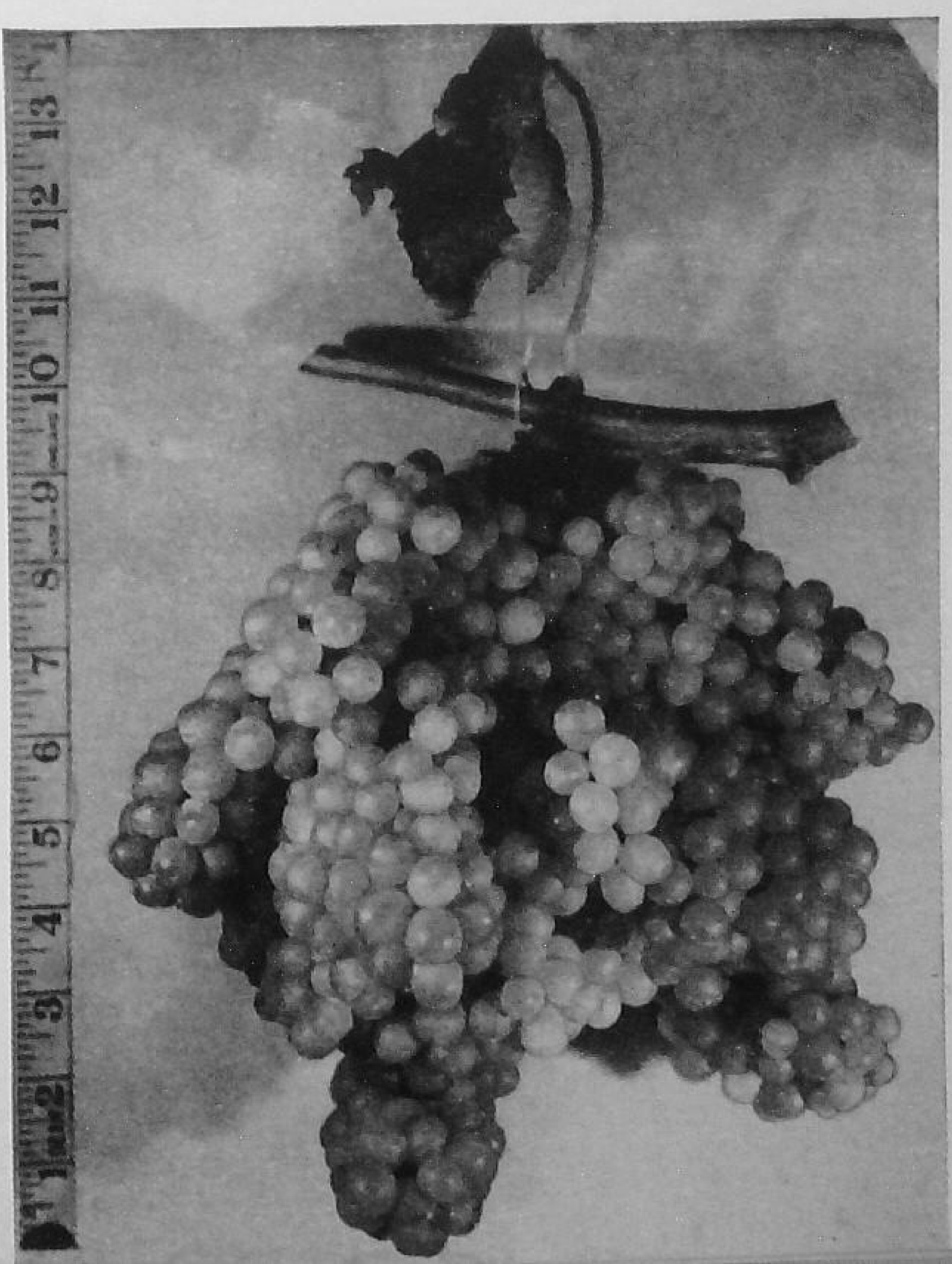
Mauritius do not need such supports ordinarily. Occasional removal of suckers, hearts and dry leaves has to be attended to. The pseudostem is also cut back or mattocked, soon after the bunch is harvested. Not more than one sucker is allowed per stool, and this single sucker yields the ratoon crops. The removal of daughter suckers should be done with care, with a sharp flat bladed instrument, without causing more injury to the parent rhizome than is absolutely unavoidable.

Flowering in bananas occurs from the 6th to 12th month of planting, and harvest of the bunch is possibe from the 8th to 15th month. With the Poovan, the harvest usually takes place between the 12th and 14th month, while the second harvest extends from the 21st to 24th month, when the plantation is generally removed. An average yield of bananas may be from 10,000 lb to 40,000 lb of fruits, while in perennial plantations it may be from 6,000 lb to 8,000 lb. The fruits are ripened by smoking or storing in godowns or hanging above an oven.

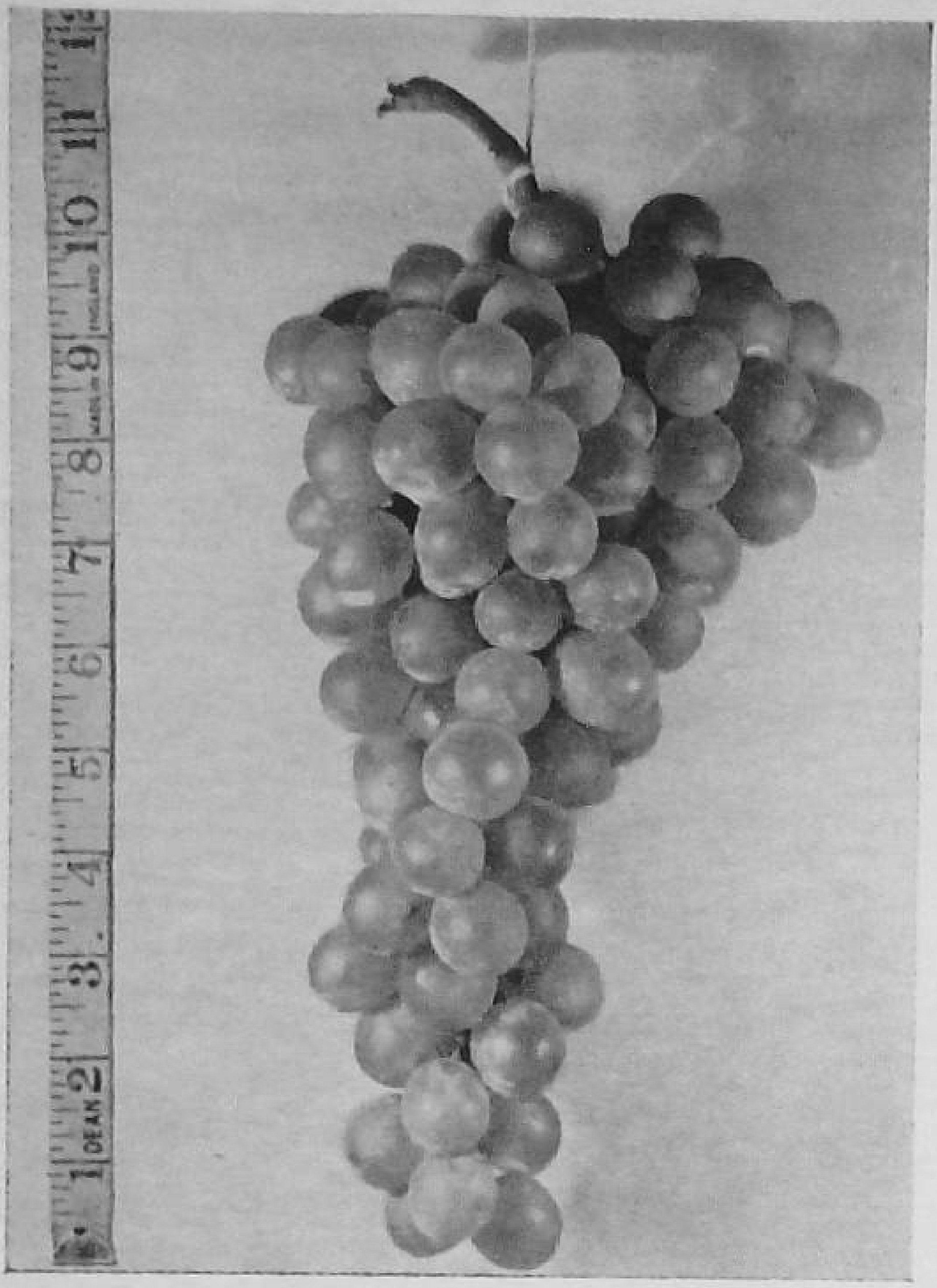
4. Grapes: Though considered to be a fruit of the temperate zone, the grape is being grown with marked success in many parts of South India. The Anab-e-Shahi of Hyderabad, the Bangalore Blue of Mysore and the Bhokari or Pachadraksha and the seedless Kishmish of the Madurai district are well-known. A deep well-drained loam or open gravelly soil is considered the best for the grape. For commercial cultivation, the grape is propagated by cuttings, which can be planted directly in the orchard at the rate of two to four per hole, but they can also be raised first in pots or nursery beds to enable the rooted cuttings to be planted in 6 to 12 months. June to January is the season preferred for planting. In poor gravelly soils, pits of about 3 ft cube are dug, and these are filled with green leaves to a height of about 2 ft and covered over with bonemeal, tank silt, well-rotted sheep or cattle manure, loose red earth and more of green leaf in different proportions, and the pit closed. The spacing varies greatly from place to place and depends on the training methods fancied by the grower. The spacing for the



View of a vine yard

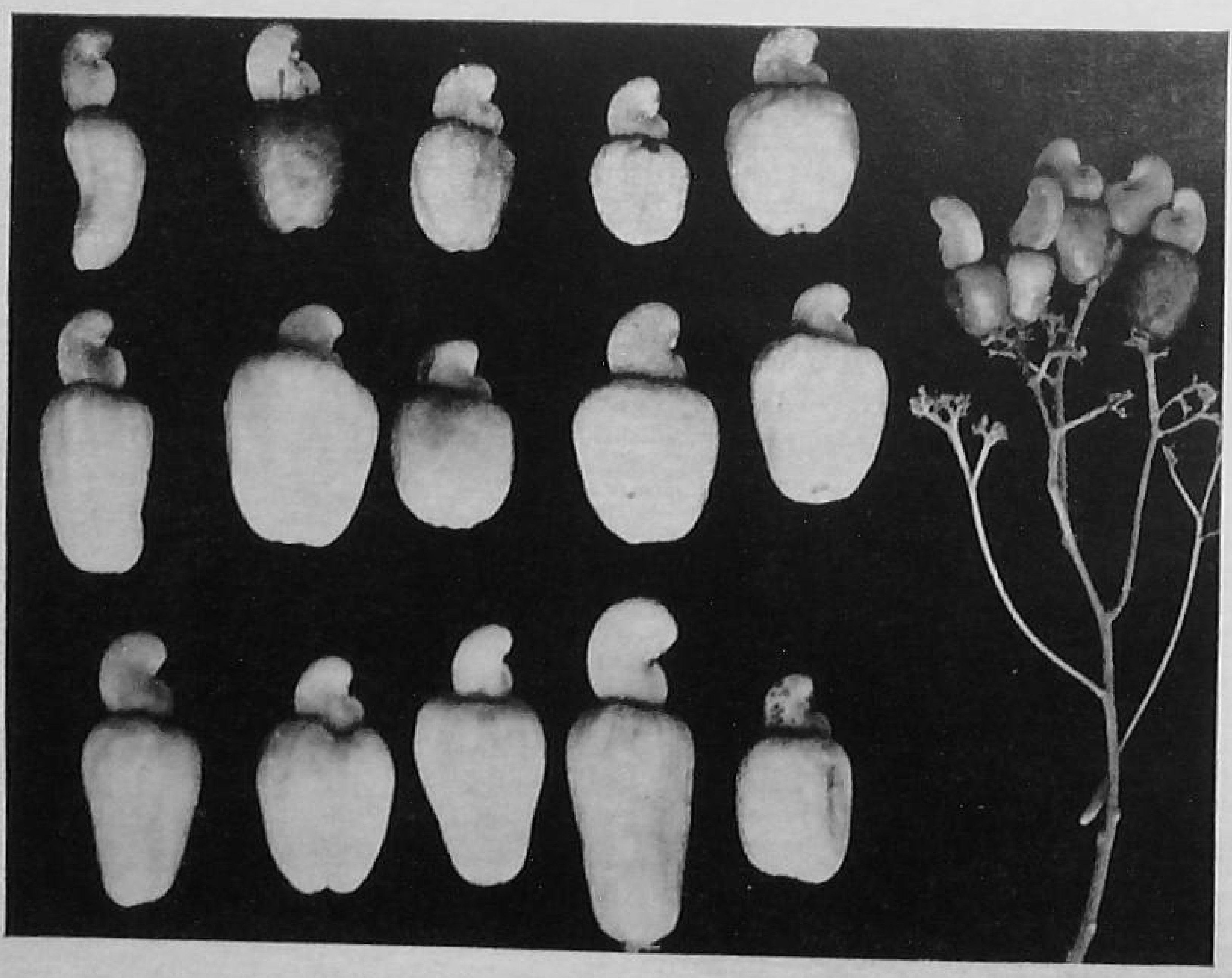


Seedless varieties of grape



Pachadraksha variety of grape

Cashew fruits with nuts of various shapes and sizes



pandal system of training the grape varies from 25 ft to 30 ft on the Penukonda side in Andhra and 8 ft to 30 ft in the Madurai district. Training on arbours supported by stone pillars is not uncommon in Hyderabad and Bangalore, while further south the quick-growing *Erythrina indica* or *Kiluvi* (*Commiphora caudata*) are planted close to the vines in the form of large limb cuttings to provide live stakes or supports. In other countries, the grape is also grown as a bush or on wires or along the walls.

The training and pruning of the vine requires to be done with care to suit the training and pruning methods proposed to be adopted. At the time of planting or soon after, the side shoots are pruned to promote only one or two trunks to develop to a height of about 5 ft, if the *pandal* or arbour system is to be followed. Side shoots removal has to be done frequently and when the vine reaches the *pandal* the growing point is nipped off and the side shoots towards the terminal part are encouraged to trail off in different directions to cover the *pandal* or the side trellis in the arbour. The trunk has to be tied loosely to the live stake or *pandal* to prevent dislodging of the vine. Under Madurai conditions, the vines grow so rapidly as to be able to produce a small crop of fruit within a year. Regular pruning begins after the vines have reached and spread over the *pandal*. For the summer crop, the vines are pruned in December-January, while for the second crop, the pruning is done in May-June. The usual practice in both seasons is to cut back all past season's growth to three to nine buds, but some growers cut back to four to five buds in December-January and to only three buds in May-June. Some also expose the roots to a depth of about 10 inches for a few hours, after which the dug out soil mixed with red earth and manure is thrown back into the pit. Many apply annually about 50 cartloads of green leaves and 100 to 200 cartloads of farmyard manure per acre by merely opening out the soil around the vines just enough to incorporate these into the soil. Being an intensively cultivated crop, timely irrigation, frequent soil culture and heavy manure applications are necessary. Disbudding of unwanted growth and

tendrils, careful distribution of the new growths over the *pandal* and loose tying of these are some of the operations that demand careful and frequent attention.

The peak harvests occur in April for the first crop and September for the second crop. Thinning of the berries and heavy application of potash have been found useful in increasing the yield and quality of berries. In adult vineyards, an annual yield of 15,000 lb to 50,000 lb of fruits is obtained.

5. PAPAYA: This fruit thrives in most parts of South India up to an elevation of about 5,000 ft from the mean sea level, though its best performance is in well-drained red loams below 3,000 ft elevation. Bad drainage is injurious to this crop. None of the varieties is able to reproduce plants true to the parent, but through careful and continual selection and growing the seed progenies of each selected parent in separate plots, it is possible to secure fairly homogenous plantations of good quality and performance. Seeds of Washington, Honey Dew and Ranchi varieties are available from such selected plantations in different parts of the country.

From seed are produced the fruit bearing female trees and the unproductive male trees, with few trees producing perfect flowers of both sexes, but giving indifferent crop yields. To secure satisfactory yields, it is necessary to retain one male tree for every 10 to 20 female trees in the plantation and an effective way to ensure this proportion is to plant out in the field three to four seedlings per hole, and to remove all but one immediately after any one of the seedlings has borne flowers when the sex can be detected.

Commercially the papaya is raised by seed, though other methods of propagation are feasible. Roughly 4 oz to 8 oz of seed would suffice for an acre. Sowing is done on raised seed beds and the seedlings are transplanted in a month to nursery beds, from where they can be lifted out when 6″ to 9″ high. For papaya large applications of manure are necessary. Roughly 20 lb of well-rotted farmyard manure at the time of planting, followed by 80 lb to 100 lb of the same four or five weeks later, repeated a year later, are considered necessary.

As it is shallow rooted, deep soil culture is to be deprecated, frequent shallow hoeing being adequate to keep down weeds. The papaya is also grown as a filler in other tree fruit plantations.

After about six months of planting, the papaya tree may flower and in another six months, the fruit may be ready for harvest. The trees continue to flower and fruit almost all the year round, yielding 30 to 150 fruits per tree, each weighing three to six pounds.

6. Sapota or Chiku or Sapodilla: This fruit grows in almost all types of soils all over the plains and up to about 4,000 ft from the mean sea level, though it prefers a sandy loam on the plains. Over a dozen varieties are under cultivation, of which the common, small fruited variety and the large fruited Cricket Ball variety are the most noteworthy. Layering is possible but inarching of sapota on *Manilkara hexandra* (Syn. *Mimusops hexandra*) is the most common method of propagation. Seedling sapotas are found to yield very low or indifferent quality crops.

Manilkara hexandra plants can be raised by seed or cuttings. Being a slow growing plant, the rooted cuttings or seedlings become fit for grafting only after about two years. Sapota seedling rootstocks are also being used in some places.

A spacing of 30 ft to 40 ft is recommended for the graft sapota plantations. Fruits are borne usually in two seasons—once in February to June and again in September to October, though some fruits can be had almost all the year round. The yield varies greatly and may go up to or over 2,000 fruits in the small fruited variety, while in the Cricket Ball variety it is much lower, rarely exceeding 500 fruits per tree.

7. Jack fruit: A popular fruit in South India, the jack is not, however, grown on any commercial scale. Besides the fruit and seeds, which are used for culinary and dessert purposes, its wood is valued for furniture-making and building purposes. Its leaves are also stitched together for use as dining plates and for wrapping. The jack grows well up to an altitude of about 4,500 ft in almost all types of soil, but is

sensitive to ill-drained conditions. Though seed propagation is the rule, inarching is now found possible on the same seedling rootstocks, as well as on other allied species. From the seed, the quality of fruit is not standard or uniform, and both the tender and firm-fleshed fruits are obtained. Rudrakshi is a small-fruited variety, which comes fairly true from seed, while a recently introduced large-fruited type known as the Ceylon or Singapore jack is also found to do likewise and produces fruit crops in three to five years as against six to ten years by the seedling jack of the common type. The jack is generally considered to be a hardy fruit and is being grown without much care or attention and without irrigation or manuring in most situations. In the Malnad areas, it is popular as a mixed crop of some value as a shade tree for coffee. The main harvest season is from March to July on the plains and April to September in the Malnad areas. The yield varies greatly, but a fair average may be from 75 lb to 350 lb of fruits per tree per year. *Artocarpus hirsuta* and *Artocarpus lakoocha* are two of the allied species, the fruits of which are also edible. The bread fruit is another allied species more widely known and cultivated, its small fruits being prized for culinary purposes. One of the types being seedless, it is propagated mainly from root cuttings, from which the trees grow to yield over 50 lb of fruits each per year after six to ten years.

8. Pineapple : This is a popular fruit grown commercially on the West Coast in Travancore-Cochin and to a lesser extent in the Malnad area and other parts of South India. A good open soil, with ample irrigation facilities and heavy manuring, are necessary for its satisfactory performance though even under rainfed conditions some yields are obtained on the lateritic hill slopes of the West Coast. It is raised both in pure plantations and also as an intercrop. Kew is the leading commercial variety, yielding large fruits from 6 lb to 16 lb each, with spineless leaves and pale fibreless flesh. Mauritius and Queen are the two other varieties under cultivation, both producing smaller fruits with the latter possessing a distinctly better flavour.

The pineapple is propagated largely by suckers, which arise from the leaf axils near the root. The slips arising from the stem, the crown, crown slips and the discs cut off from the main axis, can also be used, but these take much longer to produce crops. The suckers are cut neatly with attached roots and are planted in well-prepared soil to which heavy application of well-rotted manure or compost has been made. The spacing varies from 2 ft to 6 ft. After planting one or two applications of well-rotted farmyard manure are made at the rate of not less than 25 cartloads per acre. Mulching with dried leaves or straw is also done and regular irrigations through furrows dug between every two rows are necessary. The plants begin to yield crops from 12 to 18 months of planting the suckers and will continue to yield for two and three years thereafter, after which the plantation is grubbed out. From slips, crowns or discs the cropping gets delayed by 6 to 12 months.

9. Cashew: Though classed generally as a waste land crop the cashew responds to care. The cashew apple is a rich source of vitamin C and the nut is an important article of commerce of particular value in export trade. The cashew grows up to an elevation of about 3,000 ft, but crops best on the low lateritic hill slopes and the sandy or loamy soils of the coastal areas. Till recently seed propagation was the sole means available, but now layering or grafting is found possible. A year after sowing, the seedlings are fit for inarching or side grafting, as well as for planting out as seedling trees. There are no varieties as such, though from seed we get a large number of types and forms differing in apple colour, shape or size and in nut character. Layering and grafting, therefore, provide means to perpetuate superior forms and types. The cashew is a rainfed crop to which no manure is ordinarily applied. The mean tree yields vary considerably according to the situation, but in good sites the yields may go up to 100 lb of nuts per annum.

10. Guava: The guava is a very adaptable fruit and yields satisfactory crops under a diversity of soil and climatic conditions. However, it is seen to thrive well on open sites,

where dry atmospheric conditions and ample water for irrigation are available. The seedling trees are less satisfactory than layered or grafted trees. Among the seeded varieties, Allahabad is the best. The seedless varieties generally yield poor crops though fruits are of better quality. Roughly 15 ft to 20 ft spacing is considered adequate for the guava. Six to fifteen cartloads of well-rotted cattle manure are applied annually in adult bearing plantations. No regular pruning is done except for the removal of shoots and misplaced growths. The guava can also be trained along a wire fence and with proper regulation of growth, can be induced to yield good crops under this training system. The trees attain the bearing stage in three to four years of planting and produce two crops annually in June to July and October to December. A light crop may be harvested in other periods also. A crop of 300 to 500 fruits may be considered as average per year for a full grown tree, though the maximum may exceed even 1,000 fruits.

11. Annonaceous fruits: The custard apple, bull's heart, cherimoyer and soursop are the four commonly grown fruits in this group. Except the cherimoyer these fruits are generally found wild in many parts of South India. Though all are propagated from seed, it is now found possible to graft them on each other. This has rendered it possible to perpetuate superior types. Of the rootstocks tried, the bull's heart has proved specially suitable for the custard apple. The custard apple begins to yield crops within two years of planting from seed and is usually harvested from August to December. The soursop is rather shybearing and yields crops from June to August, while the bull's heart comes to the market from January to May. The cherimoyer thrives both on the hills and plains and is found to perform best when grafted on bull's heart, commencing to bear crops in about the sixth year as against about 10 years from seedling trees. An average yield of 100 fruits per tree is possible in good trees, when spaced about 15 ft apart.

12. Pomegranate: A hot and dry summer is congenial for the growth and performance of this fruit, provided

adequate facilities are available for irrigation. It grows both on the plains and hills up to about 6,000 ft elevation. Among the varieties grown in this part of India, the Paper Shell is found to be prolific with medium sized fruits, soft seeds and reddish to pink arils, while the Vellodu bears medium sized fruits with juicy arils but with moderately hard seeds. The Kabul is another variety fancied in some gardens but there is no definite information about its performance or quality under South Indian conditions. Though largely propagated by seed, the pomegranate is best raised by hard wood cuttings. A year after planting the cuttings, the plants can be lifted with a ball of earth and set out in the orchard, with a spacing of 15 ft to 20 ft either way. As fruits are borne terminally on shoot growths, the bearing region in this plant gets pushed farther away as the years pass, and, therefore, encouragement of a crop of new shoots through shortening of the past season's growth annually, has been suggested. The pomegranate begins to yield fruits in about three years of planting the rooted cutting and yields 50 to 150 fruits annually per tree.

13. FIG: A dry locality with irrigation facilities is suited for fig cultivation in soils of medium to heavy texture. Most of the cultivated varieties go by the names of places where they are grown or from where they were introduced. The Poona fig is perhaps the most prolific of all in South India, producing medium sized, light purple fruits with uneven shoulders and sweet, well flavoured, rosy flesh. The Marseilles yields pale green fruits with sweet, whitish flesh and is found to thrive on the hills, unlike the Poona on the plains. The fig is propagated by cuttings and the rooted plants become available for planting in six to twelve months. Layering is also easy and side-grafting on *Ficus glomerata* is possible. The spacing ranges from 6 ft to 9 ft in Bangalore, while it is about 12 ft in Anantapur and Bellary. In Mysore State, the fig is trained into a bush, by heading back the plant every year but elsewhere the fig is largely left to itself. The unpruned fig develops into a misshapen tree and regulative pruning to produce fruit bearing wood on all parts of the

tree is necessary. Some of the best crops of fig are being raised in lands supplied with sewage effluents. Heavy manurial applications are necessary elsewhere. Two applications are usually done, one in July to September and the other in January to February. Two to ten baskets of well-rotted manure are usually applied to each tree. The cultivated figs in South India all seem to be parthenocarpic i.e., they are able to set fruit without the aid of pollen from a male plant.

One year old rooted cuttings begin to yield a few fruits, but it is only after the third year that a satisfactory crop can be expected. Two crops are produced each year, one from July to October and the other from February to May. The yield is estimated at 15 dozen fruits a year from each bush in Mysore, but from adult trees even as many as 300 fruits or over are being gathered.

14. Apple : The apple growing region in South India, as also of other deciduous fruits like the plum, peach, pear, etc. is mainly restricted to higher elevations exceeding about 4,000 ft on the Nilgiris, Shevroys and Palnis, though some hardy varieties are also found in lower elevations of about 2,500 to 3,000 ft, such as those in and around Bangalore. The apple trees in South India compare most unfavourably with those in the more favoured regions like Kashmir, Punjab and Uttar Pradesh. Of the varieties which are found to yield moderate crops, the following may be mentioned :—

1. *Irish Peach* which bears scarlet coloured small fruits with soft and rather mealy flesh, but with trees immune to the woolly aphis pest.

2. *Signe Tillisch* which bears large, rose-tinted fruits with crisp, juicy and sweet flesh, also immune to woolly aphis.

3. *Winterstein* which bears large, ashy red fruits with crisp, juicy and sweet flesh, susceptible to woolly aphis.

4. *Rome Beauty* which bears medium sized fruits with dull red streaks, and crisp, tasty flesh. Trees are very susceptible to woolly aphis.

Apple has been propagated for long on the Nilgiris by the whip or whip-and-tongue grafting on crab apple rootstock, which is susceptible to woolly aphis. Clonal stocks have since

been introduced, of which Merton Nos. 778, 779, 789 and 793 have been found resistant to woolly aphis, besides being promising in other respects also. In Mysore State, the Northern Spy which is also resistant to woolly aphis is largely used as rootstock.

The apple trees are planted from July to January on the hills, usually with a spacing of 12 ft to 15 ft. Since many varieties of apple do not set a good crop with their own pollen, raising of mixed plantations is a safe procedure.

The apple is raised both as an irrigated and rainfed crop in South India, though the former is by far the more desirable practice. The manure applied to this fruit consists generally of cattle manure at the rate of one bushel per tree with about 1/4 lb each of ammonium sulphate and superphosphate for trees of about three years of age, with double the quantity each for trees between three to ten years of age. Hand hoeing is all that is done to keep down weeds with a deeper digging during the dormant season.

In Bangalore, it is not uncommon to induce two crops in a year through root pruning, once in January-February and the other in August-September. The soil is dug to a depth of about six inches to induce the leaves to shed and the pits are then refilled with soil and manure after which copious irrigation is given. In about two weeks, the trees put forth blossom and the fruits are ready for harvest in five to six months. This root pruning operation is believed to be the chief reason for the premature decline of the trees.

Apple trees are pruned to thin congested parts and to reduce long growths, as a result of which spur growths are encouraged, but with non-spur bearers like Winterstein only an annual tipping of lateral and leader shoots is done in December.

Apples are in harvest in Coonoor from April end to July, while the North Indian apples appear in the market from August to October. The average yields at Coonoor work out to about 24 lb each on prolific varieties and only 12 lb in others, with the maximum going up to 52 lb only per year.

15. Plum: The plum is grown to an extent in South India on the higher elevations above 4,500 ft from the mean-sea level. Of the many varieties tried under such conditions the following are worthy of mention:—

(i) *Rubio*. A round, crimson coloured fruit with red, juicy and sub acid flesh. Trees are very prolific.

(ii) *Hale*. Round, dull coloured with pale yellow, juicy and sweet flesh. Trees are also productive.

(iii) *Czar*. An elongated fruit with purplish crimson colour and ashy bloom. It is prized as a dessert variety.

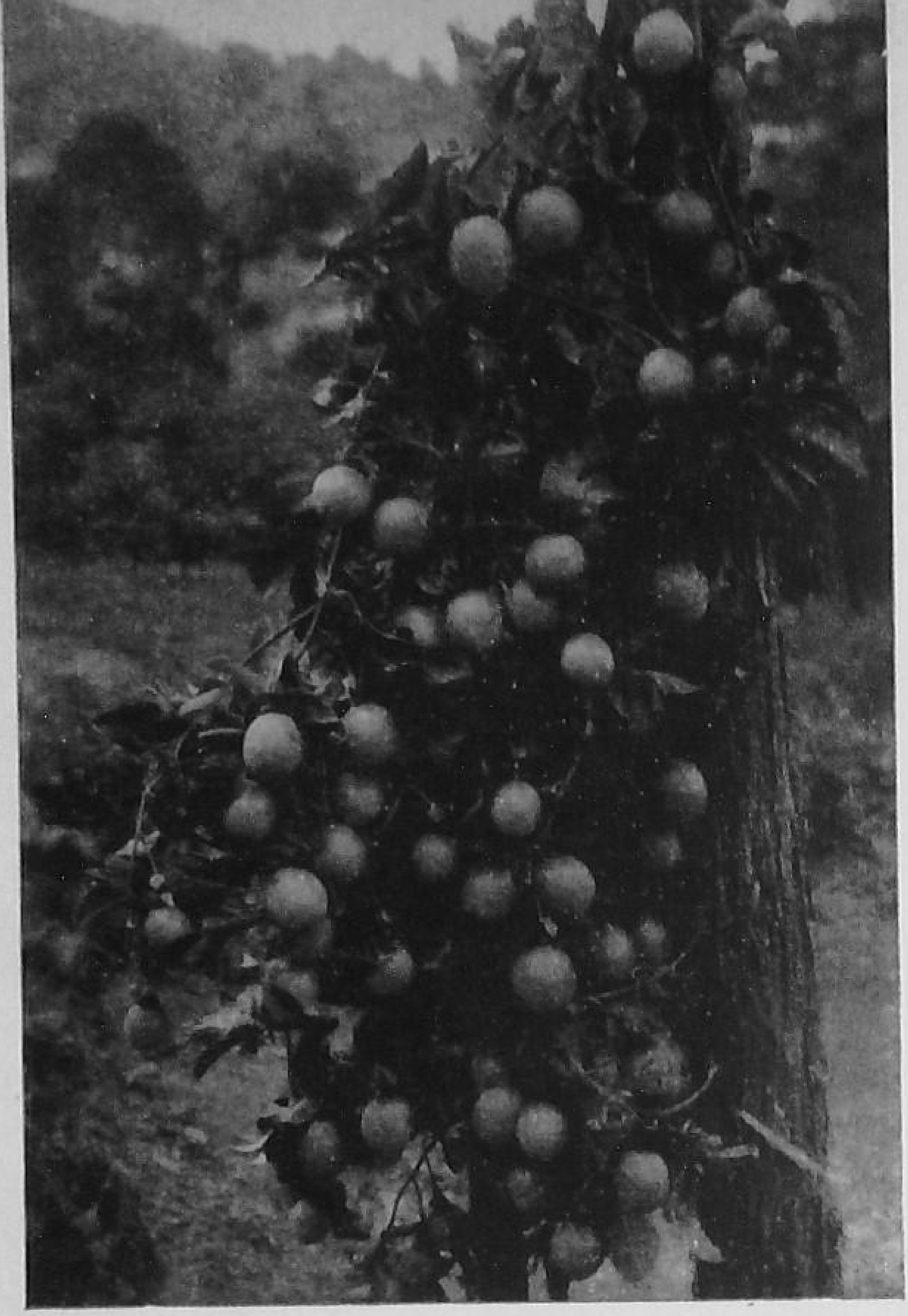
(iv) *Shiro*. Yellow coloured, large fruit with juicy flesh of good eating quality. It is considered a superior dessert variety.

(v) *Alu Bokhara*. Medium to small fruit, slightly elongated, with yellow skin colour having red splashes. Flesh is white and juicy and moderately sweet and is considered good for stewing.

On the Nilgiris, the plum is raised by shield budding on one-year-old common peach seedling rootstock. Flute budding on younger seedlings is also possible. The trees are planted generally with a spacing of 15 ft to 20 ft from November to January or from July to December, which is considered to be the second best season. Productivity in plums is dependent in most cases on the availability of pollen of a suitable variety in the vicinity for cross pollination. Some of the varieties are self-sterile, while others are scanty pollen producers. Hale and Alu Bokhara are good pollen producers, while Rubio is self-fertile. The selection of effective pollinators for each variety is, therefore, an important task in planting new orchards. Czar for instance requires to be planted amidst or close to Hale or Alu Bokhara for securing a good set.

The tree shape differs between varieties; Rubio being an example of an upright growing tree, while Hale is spreading and opencentred. In the former, the top should be opened out slightly, while in the latter, the pruning should be directed towards making the tree grow a little upright. In the bearing trees, the spurs are lateral and usually function for three to four years. It is not wise to interfere with them during this

Alu Bokhara plum in blossom



Passion fruit

Spraying against mango hoppers

period. In addition to the spurs, fruits are also borne on lateral shoots, which can be shortened with some benefit for stimulating spur production. The yearling laterals beyond the fruit spurs should also be removed. Some thinning of fruit is also helpful to increase the fruit size.

Harvest commences in April and may extend till July. Rubio yields up to about 75 lb per tree per year, while Hale has recorded even over 100 lb.

16. PEAR: The hardy pear varieties grow in more or less the same situations as the plum, but superior varieties of pear thrive only above 5,500 feet elevation in the southern parts of India. Kieffer is among the former and is the most promising, yielding large crops of pyriform fruit which becomes yellow when fully ripe with soft, slightly gritty flesh. Beurre Hardy, with its tender and very juicy flesh and Louis Bon of Jersey, with its melting flesh of fine quality, are the two popular superior varieties of pear grown on the higher elevations.

The pear is raised in the Nilgiris by whip-and-tongue method of grafting on rooted cuttings of pear. Shield budding is also possible. The trees are planted mainly in January, with a spacing of 20 ft to 25 ft. Interplanting of varieties is essential as in plums to facilitate cross pollination.

The pear is usually trained to a vase form. The culture is not dissimilar to that for the apple. In Kieffer, fruit thinning to an extent may be desirable. The fruits are ready for harvest from May to September, the trees reaching the bearing stage only in or about the eighth year of planting. Keiffer is found to yield about 75 lb of fruits per year on the average, the cropping of superior varieties being far less.

17. PEACH: This fruit grows more or less in the same situations as the plum, though some hardy varieties may yield some crop even at lower elevations, while some others require for their success the more bracing climate of the higher elevations. Killikrankie and Shanghai Seedling are the two popular varieties in the Nilgiris. Both are clingstone, but the former bears smaller fruits, pale yellow in colour with a red tinge, and with tender, moderately sweet flesh, while

the latter produces yellow fruits with red marks and pale flesh which is melting, juicy and moderately sweet.

Like the plum, the peach is also propagated by budding on common peach seedling rootstock during January to March. In Mysore State, grafting and layering are also practised. The spacing given for this fruit is generally 15 feet. The peach is usually trained to a vase shape. The annual pruning consists of shortening of the growths to force new wood, upon which alone the fruit is borne. All barren and old wood as well as the diseased or congested growths should be removed.

The peach comes to bearing in two or three years of planting and the fruits are in harvest from May to July. The maximum tree yields are up to about 5 lb of fruit. The trees are generally grubbed out after about 20 years.

17. Strawberry: This is grown usually between elevations of 5,000 ft and 7,000 ft. Only one type, which seems to be a mixture of two or three varieties, is under cultivation. The propagation is by runners or splits from the clumps, the latter being better of the two. These are planted out either as an intercrop in tree fruit plantations or as a pure crop, in March or from July to August, in rows with a spacing of about two feet between them and about 10 inches in the row. Irrigation is necessary to secure good yields. Being shallow rooted, soil culture has to be done with light hand-operated tools. A mulch of straw, leaves or ferns is spread in January, when the flowering commences and is removed after the harvest. About 25 cartloads of well-rotted cattle manure are usually applied. Stripping of old leaves and some deblossoming are found beneficial. Surplus runners are also periodically removed. Picking of fruit is done from February to July, though some fruit may be available almost all through the year except in the winter months. A mean yield of 24 fruits per stool is considered to be satisfactory. After two fruiting seasons, the crop is removed.

18. The Passion Fruit: There are three varieties of passion fruit under cultivation, among which the purple, oval fruited variety is the most popular. It thrives best at

elevations of over about 2,000 feet and is raised by seed or cuttings, the latter being quicker in yielding the plants fit for planting. Being a vine, it is grown on bowers or pergolas or against a trellis with a spacing of 15 ft to 20 ft. A hardy plant, it crops well at Coonoor with neither irrigation nor manuring. Fruits are borne twice a year, in May-June and September-October, commencing to bear from the second year of planting. Individual vine yield is about 12 lb in the second year of planting with the maximum going to 15 lb or over.

19. PERSIMMON: This fruit also thrives under Coonoor conditions. Dai Dai Maru is the most popular variety which produces orange red coloured fruits with a glossy surface and dark-coloured flesh of good quality when properly cured or ripened. Propagation is by grafting or budding on *Diospyros* rootstocks, which are not, however, readily available. The trees are planted with a spacing of 15 to 20 feet. Interplanting of varieties is recommended as this is a fruit which benefits from cross pollination. It is a tolerably hardy plant, producing fruits in about five years of planting. The fruits are in season during September. The fruits are astringent and have to be wrapped singly in paper and kept along with bananas or pears in a closed box or chamber for about three days, to ripen. Yields up to 50 lb of fruit per tree have been obtained in a year.

20. CAPE GOOSEBERRY: This is a small shrub found growing both in the plains and hills up to about 6,000 feet elevation. It is propagated by seed, and the seedlings are transplanted as intercrops, when about 6″ to 8″ high. Layering and cutting are also possible. It is treated as a rainfed crop, needing little attention by way of manuring. Fruiting commences in the first year of planting in about November if the seeds had been sown about 10 to 12 months earlier. The harvest in established plantations is, however, from January to May. Yields up to 250 fruits per bush per annum have been secured.

21. MANGOSTEEN: A delicious fruit, the mangosteen is, however, extremely localised in production, being found to

flourish only in certain sheltered situations under humid conditions and on rich well-drained soil, with ample moisture. The fruit is produced parthenocarpically i.e., without the aid of pollination and there are no varieties. Seed propagation is the rule in South India, but grafting is done in Ceylon on stocks of allied species. The seedlings are difficult to transplant owing to their long tap roots and retention of a large ball of earth around the roots is, therefore, necessary. Roughly two-year-old seedlings are planted out in orchard sites with a spacing of 28 ft to 40 ft. Shade has to be provided for young plants during summer months during the first year. Regular watering and heavy organic manure applications are also necessary. The seedlings begin to produce fruit crops from about the eighth year and the fruits are in season from January to March and again from July to December. The best trees yield 1,000 fruits or over per year.

22. Durian: A little known fruit, it is grown also in humid zones as at the foot of the Nilgiris where mangosteen also thrives. It is mainly seed propagated, though inarching on rootstocks of durian and some allied species is possible. Seedlings are planted with a spacing of 30 ft to 40 ft and these bear fruits in about 12 years, during July to September, each tree yielding up to about 50 fruits resembling a small jackfruit and possessing a flesh of rich taste but of disagreeable smell.

23. Litchi: Yielding fruits of translucent, juicy and sometimes perfumed flesh, the litchi is popular in North India, but in the South it is yet confined to only a few pockets in the humid zone up to an elevation of about 3,500 feet. A seeded, non-perfumed variety is found prolific in these parts, though other superior varieties may also prove successful. Layering and gootee are common methods of propagation, but grafting and budding on litchi seedlings or *Nephelium longana* are possible. The plants are spaced 25 ft to 40 ft and bearing commences in about six years of planting, though there are instances of trees not attaining that stage even up to ten years in some parts of South India. April to May is

the normal harvest season with individual tree yields reaching up to 300 lb per year.

24. RAMBUTAN : This is an allied fruit to litchi growing under the same climatic conditions. It is propagated by seed, by layering or inarching on the same seedling rootstock. From seed unproductive male trees are also obtained. A spacing of 20 ft to 25 ft is adequate and the individual tree yields rarely exceed 25 lb a year.

25. AVOCADO PEAR OR BUTTERFRUIT OR ALLIGATOR PEAR : This is a fruit that seems to thrive in more or less the same situations as mangosteen and also under drier atmospheric conditions as at Bangalore. A few varieties are now under trial, differing in fruit shape ranging from round to oblong and sometimes pyriform. The propagation is by seed, layering, inarching and budding, inarching on seedling rootstocks being common. Trees are planted in these parts with a spacing of about 20 feet and the culture is more or less similar to that of mangosteen. Fruits ripen in August-September and May-June and individual tree yields in South India have not exceeded 25 lb per year:

26. CARAMBOLA AND BILIMBI. Both these fruits are grown for culinary purposes and thrive in warm, moist situations as on the West Coast and on lower hill slopes up to about 4,000 feet elevation. Bilimbi is more acidic or sour and has larger leaves with a greater number of leaflets. Both are propagated by seed, layering or inarching on the same seedling rootstocks, the last being the best method. Plants are set out with a spacing of 15 ft to 20 ft. Peak harvests are from January to February and in September to October. The normal yields are roughly 150 lb per tree.

27. ROSE APPEL AND ALLIED FRUITS : The rose apple is closely allied to the *jaman*, Malayan apple and also resembles in some respects the star apple. All these yield fruits of sweetish taste of moderate quality both in arid and humid zones. They are all raised from seed, though layering and inarching are possible in most cases. The rose apple is delicately perfumed and is largely preferred to the rest in home gardens, but the Malayan apple, the *jaman* and star apple

are also grown as stray trees for their attractive fruits. The *jaman* is also popular as a roadside tree and for avenues.

28. Indian Gooseberry or Amla or Nelli: This is found wild in forests, but is also grown in home compounds for its fruits, which are reputed to be a good source of vitamin C and is also used for culinary purposes. Propagated by seed, the fruits are in season from February to July and September to January. Benaras Nelli is a large fruited type and Othehite gooseberry or Star gooseberry is a deeply ribbed fruit of similar character.

29. Zizyphus or Jujube: Though this is also classed generally as a wild fruit of the forest, there are several superior varieties which yield fruits of marketable quality and are worthy of cultivation. A very hardy fruit, it responds to care by yielding better fruits in larger quantities. A conical fruited variety of the size of a plum or a small Benaras *amla* and another round-fruited variety of the same size are grown in the drier parts of Rayalaseema. The propagation is by seed, but budding on seedling rootstocks is to be preferred. Seedlings of allied species can also be employed as rootstocks. Sometimes the seeds are sown in the orchard site itself and the seedlings are budded *in situ* after one or more years. The budded trees crop within two years of planting. The yield of a full grown tree goes up to 10,000 fruits per year. The fruits are harvested from December to April.

30. Musk and Water Melons: These are grown mainly in sandy beds of rivers where water level is high and the roots can reach the moisture layers, keeping pace with the receding water table in summer months. The water melon is also grown sometimes in loamy soils. December to June is the usual season for the raising of these fruits. About a dozen varieties of musk melons are under cultivation, of which the Bathasa, Sherbat Anar, Shiranjir, Hingan and Budumi are the most important. These differ in shape, size, colour and quality, the first being considered the best. The water melons fall into two main types, one bearing large fruits and the other producing small round fruits. Both musk and water melons are propagated by seed and the musk

melon seedlings are transplanted in a week in trenches with a handful of cattle manure mixed in the soil before the seedling is planted. Within a week of planting, bat guano and neem or groundnut cake are mixed together and applied in a ring about six to nine inches away around each plant at the rate of two tablespoonfuls. Special fertiliser mixtures are also being used by some growers. In another week, cattle manure is applied, a handful being placed around each plant sometimes with a fertilizer mixture, and earthing up is done after this. Still another application of the same manure is given in a few days in the same manner. Use of groundnut cake is now prohibited in Cuddapah melon areas as it gives rise to flies which are a nuisance to the cattle in the vicinity. The trenches are levelled after the last manurial application, after which the terminals of all the trailing shorts are pinched off to develop side shoots. Roughly after about 40 days of sowing, the blossoms appear of which rarely more than four set fruit and reach the harvest stage in each plant. The harvest commences after 70 to 80 days from the date of sowing and lasts for about 20 days. On garden lands, however, the water melon harvests extend generally from April to June.

Chapter VII

PESTS AND DISEASES

A. Pests

The following is a list of the major pests of South Indian fruit crops with the remedies suggested for each, mainly based on the recommendations of the Agricultural Department :—

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
		(1) *Mango*	
Mango Hopper	The insects suck up the juice from the flower heads and make them drop	Spraying DDT- (1 lb of 50% wettable powder to be mixed in 25-30 gallons of water) is the most effective remedy and is widely practised. Ordinarily one round of treatment will be sufficient but may be repeated if there is a recurrence of the pest	Number of these small, active, brown coloured insects attack mango flower shoots during the cold weather and do considerable damage in certain years
Mango Stem	The stout grub bores into the	Remove the grubs with a hooked	

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
BORER	stem and often kills branches and stem	wire. If impossible, syringe in to the bore hole a mixture of chloroform and creosote and plug the same with wet clay. This will kill the borer inside	
FRUIT FLIES	The white wriggling maggots of these flies burrow into the fruit pulp and spoil the fruit	Destroy infested and fallen fruits and spray foliage with a sweetened poison to kill flies	A serious pest of mango fruits almost every year
NUT WEEVIL	The weevil develops inside the nuts and sometimes damages pulp	Destruction of beetles when found and proper disposal of mango nuts after use of fruit	Affects some special varieties of fruits badly
SCALES AND MEALY BUGS	Colonies of these insects cover shoots, leaves and fruits and suck up sap	Spray Folidol (1 oz in 12 gallons of water)	The mealy bugs sometimes cause serious damage. In many cases of injury by these insects, ants are found visiting the infested leaves
MANGO SHOOT WEBBING CATERPILLAR	Webs the leaves together at the terminal ends of growing shoots and prevents the formation of flower heads	Treatment with BHC spray is very effective. (1 lb of 50% wettable BHC in 13 gallons of water)	Occasionally this insect becomes serious

Insect	Nature of injury done to plants	Suggestion for control, if any	Remarks
THE RED ANT	Does not cause any direct harm to the trees, but builds nests on mango and other fruit trees by webbing the leaves together. They wander about in numbers all over the tree and nearabout and cause considerable nuisance to workmen. Apart from this they also are responsible for spreading infestation by scale insects from tree to tree	Dust BHC 5% or spray BHC (1 lb in 50 gallons of water), particularly on the nests, the operation to be done preferably at dusk	
	(2) *Citrus* (Oranges, Lemons, Pummelos, etc.)		
CITRUS BUTTERFLY	The caterpillar defoliates the plants often seriously	Affected plants may be treated with BHC or Lindane either as a dust or spray	
THE FRUIT MOTH	The moth pierces the fruits during nights and feeds on the juice. The attacked fruits start rotting and drop down	Moths may be caught by sugary traps. Valuable fruits may be protected by cloth or wicker covering to keep off moths. Deterrents may also be sprayed to keep off the moths from fruits	

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
Shoot and Bark Borer	Caterpillar bores into top shoots and bark and has the peculiar habit of webbing galleries of powdery matter on the surface of the bark	Clipping attacked shoots and syringing as in mango stem-borer above. Scrape off the galleries and drench the stem with BHC spray	
Fruit Flies	The white wriggling maggots of these flies burrow into the fruit pulp and spoil the fruits	Destroy infested and fallen fruits and spray foliage with a sweetened poison to kill flies	
Stem Borer Beetle	The grubs bore tortuous tunnels into the main trunk and branches. and feed on the wood. The affected trees gradually dry up	Systematic clipping off of the wilted twigs; where the main stem shows symptoms of attack particularly boreholes, injection of petrol or chloroform through bore holes and plugging them with wet clay may be adopted. Adult beetles also may be collected and destroyed. Badly attacked and old trees may be pulled out and burnt	The adult beetles are shiny blue in colour, with long feelers. This is a serious pest in Wynaad causing damage to thousands of trees every year

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
CITRUS LEAF MINER	The small caterpillar mines into the leaf tissue and causes blister like patches; the leaves consequently curl and fade	Folidol (1 oz in 12 gallons of water) or Lindane spray (1 lb in 13 gallons) may be used with advantage	Sometimes all the leaves of the plant are found mined and curled up.
SCALES AND MEALY BUGS	Colonies of these insects cover the tender parts and suck the sap	Spray Folidol (1 oz in 12 gallons of water)	
		(3) *Guava*	
FRUIT FLY	Maggots bore into and damage fruits	Destroy infested and fallen fruits and spray foliage with a sweetened poison to kill flies	
SCALES AND MEALY BUGS	Cover tender parts and fruits	Spray Folidol (1 oz in 12 gallons of water)	
		(4) *Pomegranate*	
FRUIT BORER BUTTERFLY	The caterpillar bores into the fruits and damages them	Damaged fruits to be picked off and good fruits covered with loose muslin or paper bags to prevent attack by the butterfly. The butterfly can also be netted	The caterpillar is a short dirty brown creature. Attacked fruits show small holes

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
	(5) *Grape*		
FLEA BEETLE	The small beetle bites holes into tender leaves; often the foliage is badly eaten up	Spray or dust DDT, Lindane or Calcium arsenate plus lime (1 : 4)	A small copper brown active beetle
CHAFER BEETLES	The beetles come out at night and defoliate the vines often seriously	Spray or dust DDT, Lindane or Calcium arsenate plus lime (1 : 4)	These small brown beetles often come to light at dusk
GRAPE THRIPS	These appear in large numbers on tender foliage and suck sap	Spray tobacco decoction or Lindane (1 lb in 13 gallons of water).	Found on roses also
SCALES	Colonies found sucking juice from shoots and leaves	Spray Folidol (1 oz in 12½ gallons of water)	The leaves and vines are sometimes badly covered with one or more of these scales.
TERMITES	Found on roots and plant cuttings	Fields should be cleared of white-ant nests before planting. Fields showing attack may be irrigated with water containing crude oil emulsion. Raking up of the soil and application of BHC as dust or spray, are effective	Sometimes serious

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
	(6) *Banana*		
Stem Borer Beetle	The grub bores into the stem of the plant lower down and often kills the plant.	Completely remove infested banana stump and do not leave stumps after the bunches are cut. Collect beetles when found and destroy	The insect is a medium sized, dark beetle with a prominent snout and the grub is pale white
Leaf Caterpillars	Feed on the foliage	Apply BHC 5% dust	
	(7) *Jujube*		
Fruit Borer	The reddish caterpillar bores into the fruit pulp	Four rounds of sprays of DDT (1 oz in 3 gallons of water) at tri-weekly intervals commencing at the fruit setting stage	The fruit fly maggot and the caterpillar are often found together
Fruit Fly	The maggot burrows into the pulp of the fruit	-do-	This fruit fly is different from all others noted before. It is confined to this plant in Southern India. It is smaller in size also
Hairy Caterpillar	Swarms of caterpillars feed on the foliage	Spray Fish oil resin soap	

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
	(8) Custard apple		
MEALY BUG	Colonies cover the tender portion and suck sap	Spray Folidol (1 oz in 12½ gallons of water)	Sometimes very serious covering whole fruits and stalks
FRUIT BORER	Caterpillar bores into the fruits	Destroy first attacked fruits	Only a minor pest
	(9) Cashew		
THRIPS	Large numbers of these appear on the foliage and shoots and blighten the surface	Spray BHC (1 lb in 13 gallons)	Sometimes a serious pest
STEM BORER	The stout whitish grub bores into the roots, bark and trunk often killing the tree in course of time	Periodically examine trees and scrape off loose bark and destroy grubs. Apply BHC spray (1 lb in 6·5 gallons) on the trunk as well as on the soil around. Boreholes found on the stem may also be syringed with the above chemical	
LEAF MINER	The small caterpillars mine into the leaf-tissue and cause blister like patches which dry up and appear as holes on the leaves	BHC spray (1 lb in 6·5 gallons) may be used with advantage	

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
LEAF HAIRY CATERPILLAR	Appears in swarms sporadically and defoliates the trees	BHC or Folidol spray may be used	Sometimes serious
	(10) *Sapota*		
LEAF HOPPERS	As on mango	See under mango	Not so serious as on mango
MEALY BUGS	Cover shoots and stalks and suck sap	Spray Folidol (1oz in 12½ gallons of water)	Occasionally serious
	(11) *Apples, Pears and allied fruits*		
WOOLLY APHIS	Colonies of these small insects attack the roots and stem and cause galls	Remove and destroy badly infested parts and spray the plants with crude oil emulsion. Systematic colonisation of its specific parasite *Aphelinus mali* has also given good results. Resistant root-stocks as Mertons should be used	An introduced pest found only on the hills so far; very bad sometimes
	(12) *Peach, Plum*		
FRUIT FLIES	Maggots bore into fruits	Destroy first attacked fruits and trap flies by poisoned syrup spray	Bad on the Nilgiris

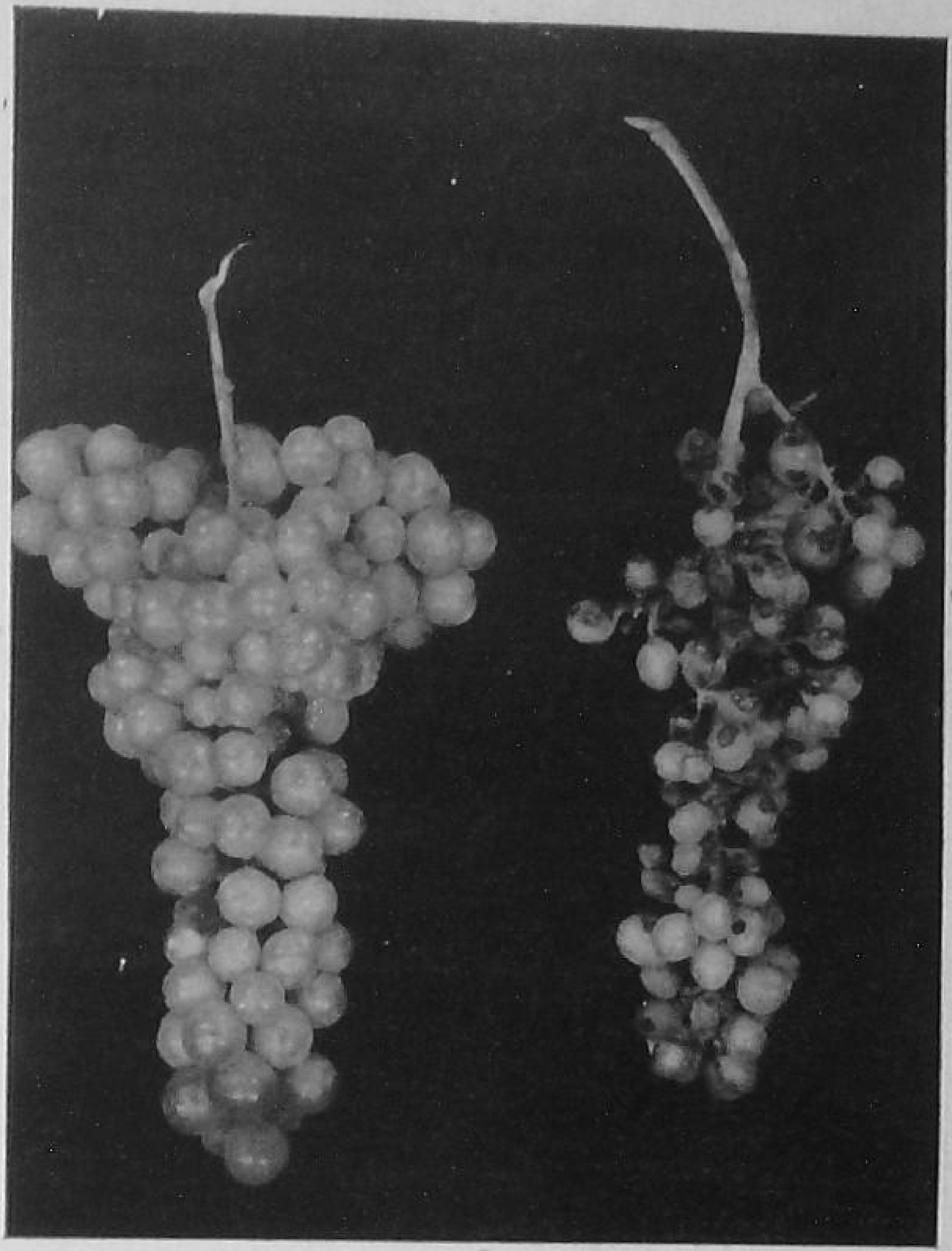
B. Diseases

A list of common diseases affecting the fruit crops in South India with their remedial measures is furnished below based on the recommendations of the Agricultural Department :—

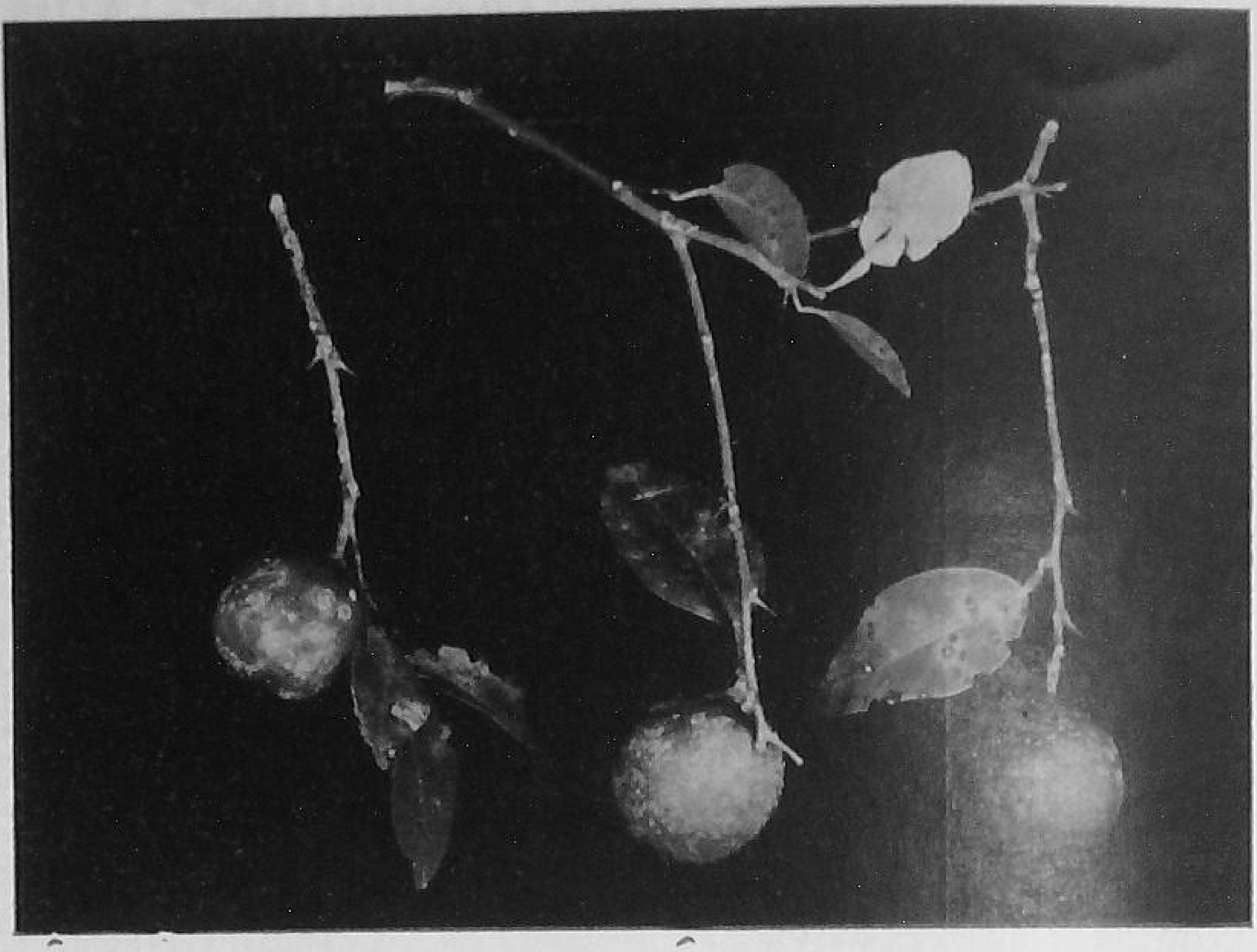
Crop	Disease	Control measures
ACID LIME	Canker	Pruning of badly affected shoots and spraying with 1% Bordeaux mixture about four to five times a year depending on the severity of the disease.
	Die-back	Provision of favourable soil conditions and nutrition including avoidance of shallow soil or rocky substrata for the orchard.
MANDARIN ORANGE	Leaf fall and fruit rot	Two sprayings with 1% Bordeaux mixture. The first spraying is given in May before the onset of the South West monsoon and the second spraying in July-August Addition of crude oil emulsion to Bordeaux mixture while spraying may be necessary to ward off infestation by scale insects
	Dry root rot	Avoidance of injuries to roots during cultural operations, provision of a mulch over soil during summer months and spraying the foliage with urea (1 lb in 10 gallons of water)
	Sooty mould	Spraying the affected portions with fish oil resin soap in combination with starch (5 lb Fish oil resin soap, 5 lb of starch in 100 gallons of water)

Crop	Disease	Control measures
MANDARIN ORANGE	Foliocellosis or Mottle leaf	Two to three sprayings on young foliage with Zinc sulphate lime mixture (5-2½-100 or 10-5-100) depending on the severity of the disease may be given in a year
	Decline	Provision of mulch over the soil in the form of dried grass or leaves between November to May, supply of adequate nutrients to the soil to keep the trees in a vigorously growing condition, avoidance of injuries to the roots during cultural operations, adoption of measures to prevent soil erosion during monsoon months, introduction of cover crops like *Calopogonium muconoides*, *Pueraria javanica*, *Centrosema pubescens* and effective control of all pests and diseases, including the stem borer.
SWEET ORANGE	Collar rot	Avoid wounding the bark at the base of the tree during cultural operations and contact of the trunk with excessive wet soil. In advanced stages of infection removal of the affected portions and protecting the cut surfaces with Bordeaux paste may be given as a curative treatment
	Dry root rot	In addition to the control measures mentioned under mandarin oranges, provision of good drainage facilities should be made
	Mottle leaf	Four sprayings with Zinc sulphate lime mixture may be given in a year (once in three months)
	Die-back	As mentioned under acid lime
	Sooty mould	As mentioned under mandarin orange

Anthracnose of grape

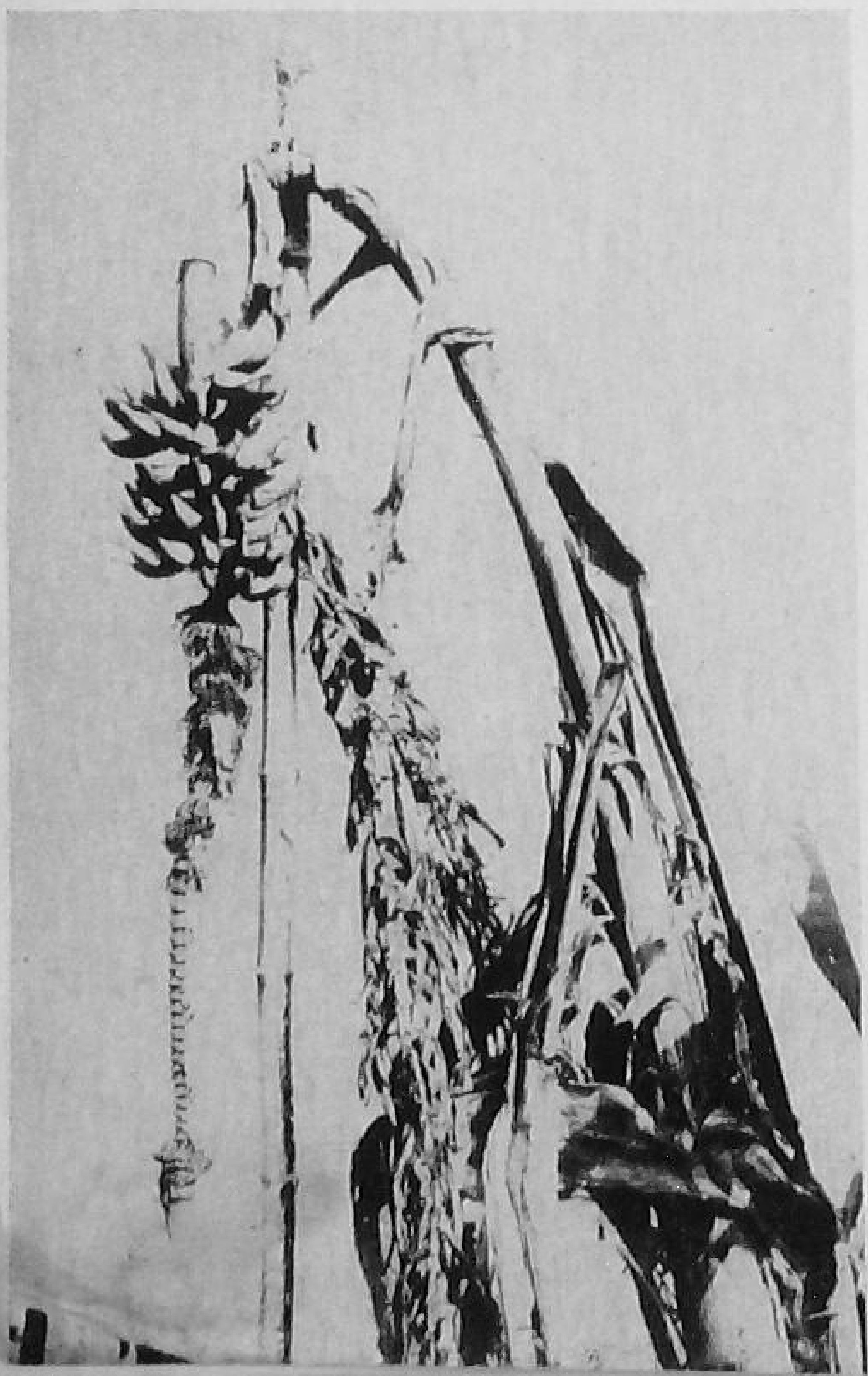


Downy mildew of grape



Citrus canker

Banana wilt



Orchard badly needing rejuvenation

Crop	Disease	Control measures
MANGO	Powdery mildew	Dusting with finely powdered sulphur or wettable sulphur. Two dustings at an interval of about a month may be necessary
	Sooty mould	As mentioned under mandarin oranges
BANANA	Anthracnose	Preventive spraying of the bunches with 1% Bordeaux mixture or other copper fungicides
GUAVA	Fruit spot	Spraying the plants with 1% Bordeaux mixture or other Copper fungicides
	Sooty mould	As mentioned before
POME-GRANATE	Leaf spot and fruit rot	Spraying the leaves and fruits with 1% Bordeaux mixture or copper fungicides
PAPAYA	Damping off and foot rot	Drenching the soil with 1 % Bordeaux mixture at fortnightly intervals in the nursery. In the case of grown-up plants removal of affected portions and application of 1% Bordeaux mixture.
JACK	Pink disease	Pruning of affected portions and protecting the wounds and cut surfaces with Bordeaux paste.
GRAPE	Powdery mildew	Dusting with finely powdered sulphur or spraying with wettable sulphur
	Downy mildew	About four sprayings with 1% Bordeaux mixture are necessary. The first spraying is given immediately after pruning, the second one when new flush is being put forth, third at the time of fruit set and a fourth one if necessary, a fortnight later. The third spraying may be substituted with sulphur when there is combined attack of powdery and downy mildews.

Crop	Disease	Control measures
GRAPE	Anthracnose	Swabbing the pruned vines with a mixture of 5 lb of ferrous sulphate and half pint of sulphuric acid in one gallon of water. After an interval of 10 days spraying with 1% Bordeaux mixture or cupravit at fortnightly intervals may be necessary
	Rust	Dusting with finely powdered sulphur
APPLE	Powdery mildew	Dusting with finely powdered sulphur or spraying with wettable sulphur
PEACH	Leaf curl	Pruning affected branches and spraying the trees with 1% Bordeaux mixture or lime sulphur
PEAR	Fruit rot	Removal of cankered branches, mummified fruits and spraying 1% Bordeaux mixture

Chapter VIII

HARVEST, PACKING AND MARKETING

Harvest: The time to gather fruits is dependent on the variety and the purpose for which the fruit is intended, as also the distance to the market. Much experience of the varietal peculiarities is necessary to determine the optimum stage of harvest. Regarding mangoes, it is advisable to pick the fruits for local markets when almost fully ripe on the trees, while for distant markets they could be harvested a week earlier. Some varieties like the Bangalora and Neelum stand transport better than others and can be picked earlier than those which tend to become very soft on ripening. Colour of the skin is not a general indication of maturity, though in varieties like Swarnarekha the fruits develop brilliant colour just a few days prior to the attainment of maturity. In citrus fruits, the picking is done rather indiscriminately, often when the fruits are very immature, which reduces their value greatly. With Sathgudi oranges, colour is an important criterion in December-January, but in the off-season crop colour fails to develop and immature fruit harvest is therefore common. This is also true of the off-season mandarin orange. Lemons, limes, grapefruits and pummeloes, however, develop a light yellow tinge when fully developed. Similar light change in tint of ground colour of bananas is observed by experienced growers, providing an indication of maturity. In grape, besides developing their characteristic ripe colour, the berries become soft, and it is easy to find from a couple of berries picked from a bunch if the bunch is fit for harvest. With sapota, the ground colour changes on attaining maturity are not always adequate and the growers, therefore, scratch the rind of a few fruits to observe the colour changes below the rind. A distinct softening of the fruit is an accurate index in figs, while in peach a springy feeling is experienced and the mature fruit

also snaps easily when lifted. In other countries, the correct stage of harvest is sometimes determined by the chemical analyses of the fruit or the pressure required to puncture the skin and flesh.

Care is necessary in handling the fruit at the time of harvest as also till it is consumed. In soft fruits, it is desirable not to grasp the fruit but only the stalk stem. In many fruits, the bloom on the skin is removed when roughly handled.

For removing the fruit from the tree a pair of scissors or clippers is helpful. Fruits should never be pulled off from the tree or fruit stalk. A clear cut to the stalk leaving a 'button' with a very small piece of stalk on the fruit is desirable. A basket or bag is useful for collecting the fruits, which should be carefully and gently placed in the containers. For mango and lime, a long pole with a curved blade or clipper at one end and with a cloth bag attached is found useful, so that the fruit drops into the bag as soon as its stalk is snapped.

It is considered that the best time for picking is early morning, provided the weather is dry. If dew or rains have wetted the fruit, bruising of its surface is likely, causing ultimately ugly spots on the rind. In citrus fruits, it is recommended that the harvest should not be done for two or three days after heavy rains. A ladder, and stools of different sizes, are useful aids for harvesting the fruits.

Packing: Before being packed, grading of fruits is necessary on the basis of size and quality, in order to ensure the supply of fruits of dependable standards. Under the *Agmark* scheme, grading of fruits is becoming increasingly popular in all parts of the country. Grading planks and machines have been devised to enable quick grading, without damaging the fruit.

The packages used for fruit have not been standardised in this country so far. Baskets are more common than crates, while for grapes earthen pots are also employed. Strong, well ventilated, light crates or cartons or baskets, where fruit is arranged carefully in single layers or in a way likely to avoid any damage to the fruit, should be the aim of all fruit producers. Each fruit or bunch should be placed

separately in a well-ordered, attractive manner and the possibility of bruising or any other type of damage in the package should be guarded against.

To improve the attractiveness of fruit, it is customary to prepare each fruit or bunch and subject it to certain treatments before packing. Wrapping of each fruit or bunch with tissue paper, cellophane or plio-film etc., helps in this direction. Some rub the fruits gently when there is no fear of loss of bloom, to remove dirt and to give a glossy surface, and even vaseline is applied to hard rinded fruit like citrus. Chemical treatments are also given as a precaution against diseases.

Packing should be tight, firm and compact, but not to such an extent as to cause injury to fruit. In apples and oranges, it is usual to finish the pack allowing a slight bulge on the top and bottom to permit shrinkage of the fruit in transit. Clean packages, free of all rotten fruits help to prolong their life and market value. Padding with light wood wool, saw dust, paper clippings, moss or smooth textured leaves is also carried out to minimise injury. A neat finish with a label showing the name and grade of fruit and its count is also necessary.

STORAGE : Provision for proper storage is of help in tiding over gluts in the market. Cold storage is not yet very popular in this country mainly because of the cost involved. Even if such modern storage facilities are not available, every effort has to be made to provide cool places for storage of fruits to inhibit or retard the process of decay.

MARKETING : Profitable disposal of fruit is the last stage in any programme of the fruit producer. In this country, the fruit producer is not as well equipped or organised for marketing his produce as the brokers, commission agents and middlemen, nor is he as assured of his legitimate share of the ultimate sale price as the other agencies. Co-operative organisations of producers are expected to correct the present anomalies.

Chapter IX

REJUVENATION OF ORCHARDS

In a long-lived crop like the fruit, continued prosperity or success can be secured only by relentless vigilance and well-informed efforts. Decline or decadence sets in either gradually or all of a sudden and timely action to detect the cause and remedy the situation is prudent. But this is not always possible nor is it always done by a vast body of fruit growers, with the result that the country is full of uneconomic orchards. To rejuvenate an orchard that is in decadence, one has to analyse the existing situation to detect the possible causes that have brought about the condition, before one can plan a programme of restoration to normality.

Rejuvenation of orchards means not merely the correction of a defect introduced or allowed to occur after the establishment of the orchard but also during the period preceding the planting of trees. Thus, the choice of a defective site or failure to guard against some of the features of an environment is as important a subject for investigation as the selection of a wrong variety or plant or the adoption of a wrong orchard practice or the failure to carry out an operation in time.

In the former category, some of the commonest items that have to be looked into are the choice of an alkaline or acidic soil, an ill-drained piece of land, defective texture or composition of soil, lack of safeguards against wild animals, cattle trespass or pilfering, absence of wind-breaks or shelter belts, unsuitable irrigation water or inadequacy of it, high cost of land, irrigation, maintenance etc., due to defective planning, nearness to disease or pest infested orchards, etc. In the latter category, the causal factors may be even more numerous, such as the wrong kind, variety, or strain or parent or rootstock, defective propagation method, deep or shallow planting, or defective training, pruning, irrigation,

soil culture or manuring practices, wrong methods of layout and position of varieties, absence of measures against soil erosion, failure to take timely and adequate measures against pests and diseases or wrong methods of pest and disease control, etc.

Where an orchard has been planted with fruits which are unsuited to a climate, there is little that can be done to improve the tree performance. One can no more expect to reap good harvest from apples grown on the plains of South India than from mangoes on higher elevations. The only palliative under such circumstances is to avoid all orchard practices which may tend to strain the trees further and to foster vegetative vigour to withstand the adverse features of the environment. It is, therefore, logical not to resort to root or shoot pruning of the apples in a tropical climate but to build up the tree strength by adequate manuring and timely and adequate measures to control the pests and diseases which serve to devitalise the trees. On the other hand, with trees like mangoes and cashew, which run mainly to leaf in humid slopes of hills and in Malnad areas, the object should be to check their growth in time or prolong their inactive phase of growth, so that the new growths may mature and put forth a blossom crop.

Where defective soils or water are the cause of orchard decadence, the rejuvenation programme should aim at neutralising the ill-effects. Gradual replacement of the soil with fresh soils of the right texture and composition is possible, though expensive. Alternative sources of irrigation are other means open to the producer. Where water table is high, deep drains can be opened and these made to discharge the surplus water to another site, away from the root zone. In a deep soil of about four to six feet depth, a number of drains intersecting the orchard or parts of the orchard are helpful in putting fresh vigour and infusing new life into the suffering trees. Addition of gypsum and organic manures is of help in alkaline soils and the addition of lime in acidic soils. Dilution of brackish water with fresh water can also be tried, where possible, to improve tree condition.

Raising of an orchard without adequate safeguards against the loss of produce is a defect which can only be got over by the provision of such safeguards. Similarly, where orchards have suffered from the absence of shelter or wind-break belts, these should be established, utilising the quickest growing trees of the region, such as *Gliricidia*, *Prosopis*, *Erythrina*, etc., which may help in minimising the ill-effects, till a supplemental belt of taller, closely-planted trees are capable of forming an effective barrier.

The location of an orchard in an area where serious infective diseases or pests are endemic, creates a very difficult situation, which calls for the united efforts of all the growers in the area. It should be the endeavour of every producer to convince his neighbours of the overriding need for co-operative efforts to root out the pests and diseases for their common benefit, with whatever assistance the Agricultural Departments can render.

When a wrong strain or variety has been planted or the plants have been propagated from a defective parent or on a defective rootstock, it is sometimes possible to rectify the position by top-working the trees to a better combination or superior scion. The conversion of inferior or unsuitable trees or varieties or scions to superior varieties is done in many ways. In the mango, for instance, the trees are headed back, leaving a few healthy and vigorous one-year-old shoots, which can be used for inarching to grafts of superior varieties carried in pots near the shoots of the beheaded tree. After the union is effected, the scion shoots are separated out of the potted graft by a cut below the point of union. If grafting is done in this way all around the beheaded tree in a few places and if all other growths below the point of union are prevented, a new scion top of the superior variety is formed. Side grafting of the trees with scions of superior varieties is also being done on the West Coast. The scions are inserted in four to six places all around the trunk at a height ranging from one to four feet. The scion shoots are inserted after making two slits in the trunk, and lifting the bark between the slits to enable the insertion of the wedged portions of

scion shoots. The tree around the inserted portion is then firmly bound over with a strong fibre and plastered with grafting wax.

Defective manipulation in budding and grafting sometimes leads to trees which are not able to grow satisfactorily. Top-working the trees below the point of union or replacement of the tree is the only solution in such cases.

Where the orchard performance is unsatisfactory due to ignorant, negligent or other unsuitable practices, the exact cause has first to be found out, before the remedy can be prescribed. In such cases, the advice of a competent horticulturist is necessary. Among the many causes for unsatisfactory orchard performance, excessive, inadequate or unsuitable fertilisation, culture or irrigation are perhaps the commonest. Many trees have suffered from the application of manures or fertilizers in close contact with the roots or stem and in large quantities. Deep cultivation or digging, when the trees are in blossom or fruit, has also resulted in the partial or total loss of the crop. Excess of soil moisture at the blossoming time has converted a prospective good crop into a total failure. Untimely or unsuitable insecticide or fungicide applications have also caused enormous losses. Rejuvenation in such cases is a matter that can be undertaken only under expert advice.

Ill-fed and sickly trees of poor performance are found all over the country. In most cases, the affected trees are sparse of vegetation, producing a few, short new growths and with a large amount of dead and diseased wood. Live parasites, like *Loranthus*, infest the neglected orchards and sap the tree vitality. A corrective pruning to clean the trees of dead and unhealthy growths, good manuring and fertilisation, adequate and timely irrigation and soil culture help to restore the trees to normal health and vigour. The producer who has been responsible for the neglect, cannot be expected to take up the rejuvenation programme actively and effectively, at any rate without the help of competent advice. In all such cases, the horticultural staff of the Agricultural Departments are available to suggest a planned programme of rejuvenation

and the producers will do well to avail of such advice so that every inch of orchard land yields the maximum produce.

PART II
VEGETABLES

Chapter I

SYSTEMS OF VEGETABLE GROWING

The importance of vegetables in the diet of a nation is now recognised all over the world. For human health, growth and reproduction, certain substances known as vitamins must be consumed in our daily diet. Of these, vitamin A, which prevents some eye diseases, infection of lungs, intestines etc., and which is essential for growth and reproduction, is found in leafy vegetables, carrots, sweet potatoes, green turnips, etc. Some vegetables are also known to be the main source of vitamin C, such as raw cabbage, green peas, tomatoes, etc. Good many vegetables provide the human system with important mineral substances, particularly calcium and iron; green vegetables being specially rich in iron. The fibrous framework of vegetables gives tone to muscles and helps in the elimination of waste matter in the human body. The laxative properties of vegetables are important in preventing or curing constipation. Vegetables thus provide a valuable food both for vegetarians and non-vegetarians. Particularly in India, where vegetables are an indispensable item in the dietary of most people who are vegetarians by tradition or on religious grounds, production of vegetables in adequate quantities is of great significance.

Experience also proves that the net returns from vegetable growing are generally much higher than from the cultivation of a vast majority of the farm crops. Many of the vegetables are classed as short duration crops, occupying the land for lesser periods than many of the cultivated farm crops. This permits the raising of two or three crops on the same ground in a year, thus enabling us to get the maximum out of the available land. Where land is not plentiful, such intensive exploitation of it is most desirable.

The planning of a vegetable garden depends on the purpose for which it is intended. Three main systems of

gardening are recognised. The first is the home garden, which is intended to supply the needs of the family with surplus for sale, if possible. Even in the city backyards or on window-sills, it is possible to grow fresh vegetables in small or large quantities. The surplus water from the well and the washing room, the litter and trash from the kitchen and byres and the spare time of the members of the family can all be utilised for making the garden successful. The quality and flavour of fresh vegetables grown in the home garden are superior to those purchased in the bazaar, since vegetables lose their freshness and character when much time elapses between their harvesting and consumption. Vitamins are specially abundant in fresh green vegetables.

Market gardens exist near important towns or cities and are intended to produce vegetables in large quantities in centres close to the markets. A feature of these market gardens is that they specialise in one or a few vegetables, practising very intensive methods of cultivation, generally using high priced land. A good deal of skill in the production of vegetables is necessary and a great deal of attention to their timely harvest, quick transport and efficient disposal in the towns and cities, should be paid. Truck farming is another system which is not in vogue in India. It is common in the U.S.A., where enormous quantities of a few vegetables are grown for distant markets and the produce is either shipped or transported by special organisations or utilised by the canning or freezing industries.

Chapter II

CLASSIFICATION INTO GROUPS AND SITE SELECTION

Classification: The classification of vegetables into groups is helpful for understanding the similarity of cultural requirements or the peculiarities of the different vegetables. Among the several methods of classification, the one depending upon the cultural requirements of crops, which is of particular interest, is as given below:—

i) Perennial vegetables such as drumstick and coccinia.
ii) Greens or leafy vegetables such as amaranthus and basella.
iii) Salad crops such as lettuce.
iv) Cole crops such as cabbage and cauliflower.
v) Root crops such as beetroot, carrot and radish.
vi) Bulb crops such as onion and garlic.
vii) Cucurbits.
viii) Peas and beans including cowpea.
ix) Potatoes and sweet potatoes.
x) Solanaceous vegetables such as the tomato and brinjal.

Selection of Site: The selection of a site for a home garden is not usually possible since one has to make use of what is already available. For commercial or market gardens, however, the selection of site is of crucial importance, for success depends principally on it.

In selecting a site, the determining influence of climate and soil has to be borne in mind. The distinction between 'hill' or 'plain' vegetables is largely due to the fact that altitude modifies the climate to such an extent as to enable the cultivation of some vegetables, where this would have been impossible but for the higher elevation. Since climate cannot be easily modified, we have to choose a locality for the

vegetables we want to grow and then choose the best site in that locality. Past attempts to grow some of the hill vegetables down on the plains have not been entirely successful.

Temperature, rainfall and humidity of the atmosphere form the chief climatic features influencing the cultivation of vegetables. Temperature determines broadly the localities suitable for different types of vegetables. It is thus impossible to grow profitably drumstick on the Nilgiris or cauliflower in Madras. Rain is particularly important, where assured irrigation facilities are not available. Since most of the commercial vegetable-growing is done under irrigation, rainfall is important only when the irrigation facilities are meagre or fail for some reason or the other. Excess of rain, however, is undesirable particularly soon after the sowing of a crop or during ripening of the crop and specially during the harvesting of seeds. Continued rains as well as high atmospheric humidity bring about increased incidence of some of the diseases and pests. Strong winds are also known to cause damage to vegetables, especially to those grown on *pandals*. All these factors have to be given their due importance while choosing a locality for commercial vegetable growing.

It is true that most of the vegetables can be grown in many different types of soils. But this does not mean that all types of soils are equally good for the purpose. It is generally believed that sandy soils are good for the production of early crops of vegetables. Such soils are worked easily, are well-drained and respond well to the application of manures or fertilisers. But they have a poor water holding capacity and they also lose their soluble plant foods more easily than loam or clay soils. For market gardening, clay soils are not chosen because of the difficulties and higher costs involved in their working. Such soils get puddled easily due to trampling by workmen. It is possible to improve such soils through heavy applications of organic manures. A well-drained loam, with an admixture of sand, is preferred for vegetable growing, since it is free from the defects associated with an excessively open sandy soil or the heavy impervious clay soil. Loams retain moisture as well as plant foods fairly well.

After selecting the right type of soil in the locality suited for the crops in view, the vegetable grower must look into some other features, before he can hit upon the best site. Since most of the vegetables thrive only in the open, it is of the utmost importance for him to see that the site does not suffer from the shade of trees, buildings or other objects. He must also avoid low-lying situations, which may become swamps during rainy season or be subject to seepage from a stream or a high-lying tank. Bad drainage can be got over by opening of big drains in some places. But such improvement is not always possible.

Nearness to the road or rail-head, availability of transport facilities, safety from pilfering and from wild beasts, protection from high winds and dust storms are other factors that must be considered before the site is finally chosen.

Chapter III

LAY-OUT OF GARDENS

In the planning and lay-out of a vegetable garden, as well as in the choice of crops, each individual has to make a decision for himself. The final choice in these matters differs widely, since everyone is inclined to grow the things he likes and in his own way. But the nature of the site and its surroundings, as well as the position of the house or the road, are all bound to influence his decision materially. It is thus clear that a standard plan of lay-out for a vegetable garden is impossible.

The planning or lay-out of a home garden is bound to be different from that of a market garden or a school garden. In the first case, the selection and arrangement of crops will depend not merely upon the area available but also on the kind of cultivation to be given, the number of persons to whom the vegetables are to be supplied and the extent of care that the family can bestow. Generally speaking, however, about 10 cents can be deemed to be adequate to supply the needs of a small family, if intensively cultivated according to a careful plan. But much will depend upon the nature of the soil and the skill of the grower. In such a garden, prominent vegetables, such as basella, drumstick, yams, chow-chow, coccinia, a few culinary bananas, can be planted on one side where they will not be disturbed by the daily or frequent rounds of operations in the seasonal vegetable section. Tall growing vegetables like cluster beans may be allotted a place where they will not shade the smaller vegetables. Plans for seasonal planting should be so devised as not to produce more of any vegetable at one time than can be used in the home. By planting at suitable intervals, fresh vegetables can be obtained throughout the year. An estimate of the area and of the sequences of planting of each seasonal vegetable must be worked out for each situation.

As for the market garden, the choice of crops depends primarily upon the demand of the market. Generally, market gardeners prefer to raise vegetables of several varieties and kinds, so that they may be able to supply to the market all through the year and thus maintain their contact with the consumers or their urban agents. This is specially the case in the market gardens situated within or close to the urban areas. In such cases, the planning and layout of the garden has to proceed more or less in the same way as for the home garden, though on a much larger area. The main precaution to be taken in market gardens, however, is to avoid the cultivation of the vegetables which are known to be infected with serious diseases, such as those caused by virus. The vein clearing disease of '*bhendi*' or the bunchy-top disease of bananas are instances of the diseases which will render vegetable growing very risky. In contrast to the home gardens proper crop rotations are the key-note of success in market or commercial vegetable growing.

It is now being realised more and more that a well-planned garden is an asset to every school, in order to teach the pupils not only the elements of gardening but also the dignity of manual labour and instil into them the idea of natural beauty. The plan for a school garden should provide for the raising of a live-hedge all round the plot with a single entrance. The entrance may lead to a plot which should be not less than 30 ft in width. On the four corners of this plot, trees such as drumsticks or jack fruit for culinary purposes may be planted. The taller vegetables, as well as other perennials like culinary bananas, may be allotted separate plots towards the hedge. In the seasonal vegetable section, a small area should be separately marked out for seed beds. A water storage pit would be useful near the seed bed area. Paths to connect the different sections should be so designed as to enable the pupils to have easy access to every plot but at the same time without sacrificing the space that could more profitably be utilised for vegetables. The channels to convey water to the various plots must be laid out with care so that they do not cut across the paths. The allocation of the plots

for vegetables should be done, in a manner to permit the vegetables requiring more liberal applications of water to be nearer the irrigation source than those which demand less of soil moisture. These principles apply to other types of vegetable gardening also, but they have to be followed meticulously in the school gardens, in order that their importance may be brought home to the minds of the young.

CHAPTER IV

PROPAGATION AND SEED SOWING

Although most vegetables are raised from seed, a good many are also raised by vegetative means, such as by the division of underground parts, by cuttings, through suckers and occasionally also through grafting, budding, etc. In Part I details of the vegetative propagation methods have been given. Here, therefore, only methods of raising vegetables through seed are described.

As in the case of all crops, success in vegetable growing depends to a very great extent on the use of good seed. To obtain the best seed in every vegetable crop is not always easy. Seed production in vegetables has become a specialised industry in many countries and the Governments have also taken over powers to enforce seed certification, so that the public may get good seed. Seed production being difficult in many vegetables, vegetable growers have to depend on the purchase of seed to some extent. Thus, every vegetable grower must know not only the value of good seed but also how to secure it at a reasonable price.

It is not enough if the seed is clean, gives good germination and is free from all the diseases and pests. It must also be true to its name and capable of producing plants yielding good quality crops.

It is easy to judge whether the seed is clean. With a little trouble, it is also possible to test the viability of the germinating capacity of the seed before we purchase it. Seed treatment is recommended to control some of the seed-borne diseases, but whether the seed is true to its name and is capable of giving profitable quality crops is a question on which the vegetable growers in the country have to rely at present entirely on the word of the seedsmen. It is, therefore, desirable that the grower himself should raise as much of his own seed as possible to meet his future requirements, but

where seed of special kinds has to be purchased from seedsmen, it is preferable to get it from the reputed or established firms rather than from a source whose only virtue may be that the seed it offers is cheap.

The grower who produces his own seed has the advantage of knowing the origin and parentage of that seed. In such cases, the grower should practise continual selection over a period of years and thus establish a reputation for his seed and build up a paying sideline. But in all such ventures, one has to remember that it is not desirable to grow more than one variety for seed purposes. When several varieties are grown, they may cross between themselves and the seed resulting from such indiscriminate crossing may be of little or no value.

Whether the seed has been collected by the grower himself or purchased from another source, it is desirable to conduct germination tests before sowing. This precaution may avoid the loss that is bound to follow from the sowing of bad seed. Moreover, by such tests we can estimate the quantity of seed to be sown per acre for securing a good stand and thereby we may avoid the need to fill the gaps or to resow. Particularly in the case of old seed, germination tests should be considered indispensable.

Seeds of our common vegetables like bhendi, cowpea, etc., are sown directly in the field, while in the case of some other common vegetables like brinjal, tomato, cabbage, cauliflower, etc., it is necessary to raise the seedlings in the nursery and later transplant them.

Raised seed beds are used for all vegetables, the beds being made to rise a few inches above the ground level. Usually a bed is not more than 4′ wide and 6′ long. The soil has to be dug and worked thoroughly before the bed is prepared. Perfect tilth is necessary for the bed and all extraneous matter or hard clods, pebbles or stones have to be screened off. A basket-ful of well-pulverised and well-rotted cattle manure or compost is usually applied and mixed well into the soil.

The seeds should be sown in lines. When very small seeds are used they are usually mixed with very fine sand

before sowing. When seeds are sown thus, a uniform stand is obtained. Otherwise the small seeds tend to be distributed unevenly in the bed. The seeds are covered lightly with a fine layer of soil. A light shade with a temporary, low *pandal* is useful, lest the seed may be damaged by the strong rays of the sun. Watering through a fine rosecan, to permit the water to reach the seed in a very fine spray or shower, is done soon after the sowing. Negligence in this respect may result in dislodging the fine seed, leading to low germination and uneven stand.

Preparation of land for vegetables such as bhendi, which are sown directly in the field, has to proceed in the same manner as for the seed bed, except that raised seed beds are unnecessary and watering can be done in the field through channels specially made for the purpose. In the case of greens, like amaranthus, the sowing is done by broadcasting in level beds prepared in well pulverised soil, having small bunds on all sides. The water should be let into the beds slowly so that the seed which is sown about 1/4″ below the soil is not disturbed or dislodged. For carrot and radish, similar beds may be used but seeds may be sown with 4″ to 6″ spacing. Seeds of bhendi, beans, etc. can be sown ½″ deep in the furrows, which may be opened at suitable distances ranging from 12″ to 24″, after which water can be allowed into them. More spacing is necessary for pumpkins and cucumbers, seeds of which, as a rule, are sown at the rate of four to six per hole, 6 feet or more from one another followed by watering by hand or through specially prepared channels. For chow-chow it is usual to put down the ripe fruit with a sprout in each pit.

The time for sowing depends partly on the season and partly on the requirements of the family or the market. In the plains, January to April is the normal season for sowing summer vegetables, while for the cold season August to December is the period. On the hills, however, February to June is the usual sowing season.

Chapter V

PREPARATION OF LAND AND PLANTING

When the land is occupied by the same crop year after year or season after season, there is a progressive deterioration in crop yields. The land is said to have become 'sick' for that particular vegetable. The same result is noted when plants belonging to the same family are grown on the same site for some years in succession. Crop rotation is, therefore, recommended to counter the ill-effects of the system. When a crop is followed by another with which it is not related, not only the soil fertility improves but pests and diseases are also reduced.

Rotating a deep rooted crop, such as radish or carrot, with a shallow-rooted crop, like amaranthus, or *vice versa* is therefore advocated. It is even better when a leguminous crop, such as bean or pea, is rotated with a non-leguminous crop, like brinjal, 'bhendi', potato, etc. Leguminous crops are known to enrich the soil with nitrogen obtained from the atmosphere, besides countering the ill-effects of monocropping.

Where rotation or heavy manuring which is also required in intensively cultivated vegetable areas, is not possible, occasional fallowing of land is to be recommended. This would mean the provision of a break in the continuous cropping of a soil. Keeping the land vacant for sometime helps to restore the fertility and bring back the soil to a better condition for the next crop. During the fallow period, the soil may be worked well by repeated digging or ploughing to expose it to the sun and air, as well as to prevent its deterioration through weed growth.

When the first four or six leaves are fairly well-developed in the seedlings grown on seed beds, they are fit for transplanting in the field. Before pulling out the seedlings, the seed bed should be soaked well with water. The transplanting

may be done on a cloudy day, preferably in the evening, so that the freshly planted seedlings will not be exposed immediately to the sun. The seedlings should never be pulled out so as to leave no soil around the roots. The retention of a little soil adhering to the roots means a greater possibility of securing a successful stand. The seedlings may be planted a little deeper in the field than in the seed bed. The planting is done in small holes in the well-pulverised soil of the field, after which the soil is pressed around the plant firmly. Only robust and healthy seedlings should be planted in the field, and all weak, diseased and damaged seedlings should be discarded. The plants should be set in straight rows with an even spacing. This not only gives a better appearance but also renders the cultivation easier.

Chapter VI

AFTERCARE

Manuring : Since under a system of intensive cultivation the land is ploughed and worked frequently, a rapid loss of the organic matter occurs in the soil. Such a depletion of the organic matter is very rapid in tropical soils, being hastened by the increased bacterial activity through better soil aeration. Replacement of this loss by the addition of plant foods to the crops grown, therefore, is an important task. Particularly in sandy soils, heavy applications of organic matter are helpful in making the soil less porous and thus increasing its water-holding capacity. In heavier soils also, organic matter helps to open up such soils. In most of the home gardens, as well as perhaps in market gardens, well-rotted cattle manure and compost are the most popular manures applied. These are particularly important for basal dressing before the soil is made ready for planting. All types of organic manures should be worked thoroughly into the soil if their full benefits are to be reaped. Fertilisers are being increasingly used in recent years, but where organic manures are available in plenty it has been possible to raise good vegetable crops without the aid of artificial fertilisers. The availability of organic manures being a problem in many places, artificial fertilisers are likely to play an increasing role in vegetable growing. Among these, quickly available nitrogenous fertilisers like ammonium sulphate are specially preferred to secure rapid growth in such crops as leafy vegetables. Of late, urea has been used. This fertiliser has about 46 per cent nitrogen in a readily available form and can be used as a spray by itself or in combination with some insecticides or fungicides. Phosphatic fertilisers are useful for encouraging root development, and are of particular value for the raising of root vegetables. They are also desirable to hasten maturity in crops like cabbage, tomato, lettuce, etc.

Potash fertilisers are considered to be of help in the pod formation of peas and beans in particular. Lime as well as other trace elements like copper, magnesium, boron, iron, etc., are also reported to be helpful in promoting successful vegetable culture under certain situations. Since research in this country has not progressed very far, it is not possible to recommend the most useful fertiliser and manurial schedule for each vegetable crop in each tract or zone, except to some extent in a few crops like potato and banana. Fertiliser mixtures are now in the market and are being used to some extent in the cultivation of several vegetables. Till definite knowledge about the value of these for each crop is gained, it is difficult to express an opinion about them. Generally speaking, however, it may be stated that all salad vegetables require more nitrogen than other vegetables, but when certain leafy vegetables are grown under excess of nitrogen, they produce only very tender and succulent growth, which is liable to wilt quickly after removal from the field. Fresh manure has been generally found to be injurious to vegetables. The normal dosage of well-rotted cattle or farm yard manure is 10 to 20 tons per acre, in addition to artificial fertiliser applications. Although sulphate of ammonia, superphosphate and sulphate of potash are the most commonly used artificial fertilisers, the last one is generally applied only for potatoes, sweet potatoes and tapioca. The Nanjanad mixture which has been evolved by the Madras Agricultural Department is comprised of 100—200 lb of sulphate of ammonia, 200—500 lb of super-phosphate and 100—200 lb of sulphate of potash per acre. This mixture is applied to potato in one or two doses, at the time of planting and again during the first or second earthing up operation. As is the case with all other artificial fertilizers, the mixture is spread between or around the plants and worked into the soil around the roots at the time of earthing up. Every application should be followed immediately by irrigation. In the case of organic manures, however, the application is done either as a basal dressing before the soil is ready to receive the seed or plant or after the planting or as much around the

plants. In the first two cases, the manure should be worked into the soil by repeated ploughings or digging so as to completely mix it with the soil. When the manure remains in clods or lumps, much of it is either wasted or it may even cause injury to the plants.

IRRIGATION: As previously explained, timely irrigation in adequate quantities has a decisive influence on the success of vegetable growing. In most vegetables, except in seed beds or flat beds such as those used for amaranthus, furrow irrigation is the rule. The actual frequencies of irrigation vary with the crop, the season, the nature of the soil, the age of the crop and the extent of rainfall, so that a definite recommendation is not easy. Normally, however, irrigation to most vegetables is applied once a week, except during the very hot periods of the year. The safe procedure, to determine the need for irrigation, is to have a rough soil test as mentioned already in Part I.

It is necessary to emphasise, however, that vegetables like all crops differ considerably among themselves for their soil moisture requirements. Generally, with abundant moisture, a more rapid and succulent growth results. It is the experience of salad vegetable growers that a higher quality, earlier maturing and better size are achieved when the crop is supplied with adequate moisture throughout its growing period. Splash irrigation is sometimes resorted to in vegetable fields, and more particularly when water is scarce or planting is done on high ridges and for seed beds. Where furrows are at a distance from each other, occasional splash irrigation is necessary to keep the plants supplied with adequate moisture. It is preferable to have an adequate number of furrows to ensure that all the plants have good access to water. Excess of irrigation, however, is an evil which may cause considerable harm, particularly to the young seedlings. Much damage often results owing to the vegetables coming in prolonged contact with irrigation water or wetted soil. Small grass beddings are often provided where vegetables like cucurbits, gourds, etc., are likely to come in contact with soil or soil moisture.

CULTIVATION : Cultivation in vegetable growing is essential for destroying the weeds which compete with the vegetable crops for moisture and nutrients. Soon after the planting of vegetables in well-prepared soil, weeds begin to grow and these compete with the crop in an increasing measure. Timely weeding to remove such competition is, therefore, of great importance. At least two hand weedings are necessary in most of the vegetable growing sections. The timing of these weeding operations has to be judged by the grower himself, depending upon the nature and extent of the weed growth in each field. Many vegetable growers combine the weeding operation with the earthing-up operation. Earthing up is done usually 15 to 30 days after planting or sowing and again once after a fortnight or a month. Apart from the partial weeding which is done with the earthing up, two hand weedings are commonly given in most vegetable areas. Sometimes where weeds are particularly bad, one deep cultivation, such as a thorough digging with *mammutties*, becomes necessary.

TRAINING : Several vegetables require to be trained on a *pandal*. In the case of pumpkins and cucumbers, though they too have a trailing habit, *pandals* are not provided, the general practice being to allow them to trail on the ground, placing the fruits on some straw mulch so that they may not be damaged through contact with the soil or soil moisture. Snake-gourd, bitter gourd, coccinia and basella have to be trained on *pandals* specially erected for the purpose. Some varieties of beans also require supports or *pandals*.

STAKING : Staking peas, beans and tomatoes is also commonly practised in order that these may bear fruit properly.

CHAPTER VII

ROTATION, SUCCESSION AND INTERCROPPING

The value of crop rotation has already been dealt with earlier while discussing the preparation of the land for planting vegetables. As already stated, rotation is the name applied to an arrangement whereby different crops are grown in a prescribed sequence on the same land. It is intended to maintain the soil in a sound state, instead of allowing it to be exhausted by cropping the same vegetable year after year and season after season. All crop rotations, therefore, endeavour to balance the utilisation of vegetable plant nutrients. Further, crop rotations check the incidence of pests and diseases. Some of the virus diseases can be controlled if the field is kept free of the crops susceptible to the disease for certain periods. Some of the common systems of crop rotations comprise (i) growing a leguminous crop like cowpea and cluster beans after a non-leguminous crop like bhendi or brinjal; (ii) growing onion, radish and similar crops which will return little to the soil in the form of plant residues, followed by crops like cabbage, which leave behind large quantities of plant material; (iii) alternating a shallow rooted crop like amaranthus with a deep rooted crop like yam or sweet potato and (iv) following a foliage crop with a root crop.

When two or more crops are grown in the same land in the same season, the practice is termed as succession cropping. The object of this is to have in the same field crops of different duration so that when the early maturing crops are harvested the longer duration crops will have adequate space for growth and development. Many combinations of crops can be adopted to suit the taste or the needs of the market. Heavy manuring or fertilisation is necessary when this system of cropping is followed. This system of growing two or more crops together on the same land is also some-

times known as companion cropping. When vegetables are grown in fruit orchards, using the space between the tree rows, intercropping is the name given to the system. This system is usually adopted in the early stages when the fruit trees are in the prebearing stage and are unable to utilise all the orchard space. Later when the trees grow to their full size and shade the entire ground, intercropping of the vegetables is not possible.

Chapter VIII

IMPORTANT VEGETABLES

I. Perennial vegetables

(1) Drumstick: This is rich in iron and vitamins A and C. Apart from the fruits which are made into several culinary dishes, the leaves and flowers are also used in various ways. The leaves and bark are used in medicines to promote digestion. The trees are also useful for training betel-vines. Drumstick is also planted as an intercrop in coconut or other tree plantations.

It comes up well in most types of soils though a sandy loam is the best. Being a tropical plant, it thrives well only in the plains. The propagation is from seeds or limb cuttings. Large limb cuttings, 3′—4′ in length and 6″—8″ in circumference, are planted *in situ* in the rainy season. The spacing varies from 10 to 25 feet.

There are not many named varieties. A variety called *Jaffna* has been in cultivation in South India for a long time. It produces long fruits of about 2′-3′ in length containing plenty of soft flesh of good eating quality.

Trees are watered in hot weather about once a week. Manuring is rarely practised but application of green leaves, farm yard manure and ash in basins about 1′ away from the base or in shallow trenches in the rainy season has been found beneficial. Weeding and hoeing of the tree basins once or twice a year are necessary.

The plants established from cuttings will begin to bear from the fifth or sixth month and from seedlings in about a year or two. A good tree may yield about 1,000 fruits per year. In South India, the drumstick bears in two seasons—July to September and March to May.

As a result of its straggling growth, old trees often become ill-shaped and ugly, with high branches at the ends of

which fruits are produced with attendant difficulty in harvesting.

In such trees, old, high and ill-shaped branches should be removed. This will promote new growth on which fruits will be produced.

(2) COCCINIA INDICA: Tender, immature fruits are used for culinary purposes. It is propagated by cuttings 1′ long, planted either flat in pits or tied up in the shape of a ring and one such ring is placed in each pit. Cuttings are also sometimes planted vertically, three or four being planted in each pit. The plants are trained over a *pandal*. The vines flower and fruit two to three months after planting. The spacing between pits may be 6′ to 9′. The best time for planting cuttings is June to July. Fruits are available from December onwards. The yield is maximum during the hot weather months of April and May.

Fish guano when applied to the plants has given increased yields. The vines have a rest period in winter and can be pruned in January to promote new growths. They continue to yield for 3 to 4 years, after which replanting should be done. The yield may range from 4,000 lb to 5,000 lb per acre.

There are two varieties: (i) small fruited and (ii) long fruited. The latter is the more profitable to grow. The vines bear well for about nine months in a year. A variety is also known yielding bitter fruits.

(3) CHOW-CHOW OR VEGETABLE MARROW: This comes up very well at higher elevations. In the plains it can be grown in places which enjoy a cool climate like Coimbatore, Bangalore, etc. It is generally propagated by planting the whole fruit in specially prepared pits. Though *pandals* can be erected for the vines to trail over, usually the vines are allowed to climb on small trees. The vines come to bearing in about four months and yield on an average 50 to 60 fruits per season. If properly attended, the vines live for some years and continue to give good yields. The fruit, which is the edible part, should be gathered before it is fully mature; otherwise it will become stringy and fibrous.

(4) Agathi: This is generally grown as a standard for betel-vine and a few cuttings can be planted in the home garden also. The tender leaves, flowers and immature fruits are used in culinary preparations. It is propagated by limb cuttings, 2 to 3 feet long and 4 to 6 inches in circumference and is rich in iron.

II. Leafy vegetables

(1) Basella (Indian spinach): It is a favourite vegetable of the West Coast, but can be grown successfully in all areas. The succulent stems and leaves are used for culinary purposes. There are two varieties, one green, the other purplish red, the green being the more popular. It is propagated through seed, as well as stem cuttings—which are 2′-3′ long. The latter, however, is preferable as the plants grow quickly and yield green leaves within a short time. The cuttings are planted in June-July in 1½′ cube pits filled with a mixture of a basket each of cattle manure, ash and burnt soil. Being a perennial climber with succulent stem, the vine has to be supported on *pandals*.

Within 1½ to 2 months after planting, it will be possible to take cuttings for culinary purposes. Thereafter, cuttings can be had for about a year almost once in four days. The vines can be kept, under proper attention, in the same place for several years.

(2) Amaranthus: There are many varieties in amaranthus, differing in the colour of leaf and stem and in the size of leaves. Amaranthus grown in some places like Tiruvallur are reputed for quality. In Thandukeerai there are red and green varieties. The plants of Thandukeerai are harvested when the seedlings are less than 9″ high and are called Molakeerai. There is also a variety known as Araikeerai which is of six months' duration and is very popular near Madras. This yields for about a year. Excepting these two varieties viz., Thandukeerai and Araikeerai, all other amaranthus are retained in the field for about 2½ months only.

Seeds can be sown throughout the year and as many as five to six crops can be raised in home-gardens every year.

The seeds are usually broadcast but transplanting of seedlings is also practised, chiefly on the West Coast. The seeds are broadcast thick and thinned out later to give a spacing of 6″×6″ between plants. The seed rate is about 2 lb per acre. Transplanting is done in order to obtain large plants and the seedlings are then set out at 1′ spacing.

Amaranthus does not require any special cultural attention. Heavy doses of cattle manure as basal dressing, however, help to produce a good leafy growth. Regular watering is necessary.

The Molakeerai is removed completely before it attains a height of about 9″. In the case of others, monthly cuttings are taken for a period of three to four months on the West Coast and two to two and a half months in other places, the first cutting being obtained a month after sowing.

The yield is estimated at 10,000 lb per acre of green matter.

(3) Gogu or Roselle: The fleshy enlarged calyces and leaves of this plant, which have a pleasant acid taste and a very attractive red colour, are used in the preparation of chutneys.

There are red and green varieties and of these the former is considered to be the more useful for culinary purposes. The plant can be propagated both by seeds as well as shoot cuttings. Seeds can be sown almost throughout the year but March-April sowings give rise to vigorous plants. The cuttings can be planted in the rainy season. The seedlings come to bearing in about five months after sowing, while the rooted cuttings take only three months. The calyces are gathered when they are tender, plump, fleshy and of deep red colour. Yield per acre is 10,000 to 14,000 lb.

(4) Tailinum or Ceylon spinach: This is a leafy vegetable which can be used in the same way as Basella and can be grown easily from cuttings as well as seeds. This plant relishes shade and grows luxuriantly in backyards. Tender shoot cuttings are used for planting. The plants can be grown all the year round when there is sufficient moisture. They thrive well in all localities and are an excellent substitute for

amaranthus. The preparations are a little mucilaginous and not relished by some. But by boiling in tamarind water, the defect can be removed. This vegetable is also reported to be rich in certain vitamins.

(5) Spinach: This is grown for its leaves which are relished by many in almost all seasons. As a companion crop, it can be grown amidst peas, cabbage and other comparatively slow growing crops. Under good conditions of soil and manuring, spinach may become available for the table within a few weeks of sowing.

The spinach varieties are broadly divided into two groups, one having round seeds and the other tubercled seeds. The crop is grown on the hills all through the year but shady places are selected for the summer crop. It is sown direct in the field. After the plants produce two or three leaves, they are thinned out giving a spacing of about 3″ between plants. A second thinning is done after the first cutting of leaves, leaving a spacing of about 6″ between plants.

The harvest consists in the periodical removal of the longest leafy tender stems.

(6) Sukkakulu or Chukkakeerai: This is another popular leafy vegetable of the Telugu tracts and is very quick in growth. Seeds are sown in small beds in home gardens and the leaves can be gathered within 30 days of sowing.

III. Salad Crops

These are leafy vegetables usually eaten uncooked. They are especially valuable for their ash constituents and for their vitamin content. They thrive best in the cooler areas but are difficult to grow where temperatures are high. Of the salad crops, celery and lettuce are the most important.

(1) Celery: It comes up in places with low humidity and plenty of sunshine. There are two varieties—green and yellow. The seed rate is 4 oz per acre. The seedlings are transplanted in shallow trenches 24″ to 36″ wide. Rapid growth is essential for good yields and high quality, and liberal applications of manures are therefore made. Grow-

ing the plants in subdued light results in a properly blanched product of high quality with crisp, tender and mild flavoured stems. Blanching is effected by progressive earthing up of the leaf stalks, which is continued up to a week before the harvest. The crop is ready for harvest about four months after sowing.

(2) Lettuce : There are a number of varieties which can be grouped mainly under two kinds, viz., cabbage lettuce and 'cos' lettuce. The former forms a small head like cabbage and needs no special effort in blanching, while the latter is upright in habit and has to be blanched. The latter varieties are coarser but easy of culture. White Heart is one of the good varieties of 'cos' lettuce and has done well at Coonoor.

The crop comes up well in rich soils well supplied with organic matter. Seeds are generally sown in January-February or in August-September, although on the Nilgiris and in Kodaikanal sowing can be done almost throughout the year. A succession of sowings, once a fortnight, can meet the daily demands of the family. The seed rate per acre is about three ounces.

Lettuce can also be found in places like Coimbatore. Success in its culture seems to be dependent on the low mean temperature during the heading period and on the opportunity provided for its quick growth. It is a good companion crop and can be grown between rows of cabbages and cauliflowers on the hills.

Best leaves are produced by the plants raised *in situ*. Transplanting, therefore, is not recommended for home gardens. When the crop sown direct in the field grows to some height, the plants have to be thinned out leaving a spacing of about 12″ to 18″ between the plants. The crop takes about eight weeks to be ready for harvest.

IV. Other Salad Crops

Chikurmanis : Propagated by seed, the leaves of this plant are eaten raw or after being steamed. It is believed to be richer than amaranthus and several other vegetables in vitamin A, B and C.

V. Cole crops

Cole crops form one of the most important groups of vegetables. This is a hardy group and consists of cabbage, cauliflower, broccoli, brussels sprouts and knolkhol (khol-rabi). All these vegetables are closely related to one another, and grow best in cool moist situations and their cultural requirements are more or less similar. They are also subject to the same pests and diseases and cross readily with one another.

All leafy cruciferous vegetables, particularly the outer leaves of the cabbage, are important sources of minerals. Of these, calcium, which is helpful in building up bones and teeth, iron for the formation of haemoglobin in the blood, iodine for the proper functioning of the thyroid gland and phosphorus for the proper formation and functioning of the body cells, are the most important. These vegetables possess also vitamins to some extent.

(1) Cabbage: The part eaten is the 'head', which is merely a cluster of congested, unopened leaves around the growing point of the stem. It is essentially a cool season vege-table, and is a biennial, though cultivated as an annual crop. As a biennial, it produces in the first year a compact leafy head ending in a terminal bud. In the second year, inflorescence emerges.

Although cabbage is mainly a hill vegetable, appreciable success has been obtained in growing this as a cold weather crop in many parts of the plains with moderate elevations. On the West Coast, however, this vegetable has been a failure.

Though it comes up in a vast variety of soils, a well drained fertile loamy soil, well supplied with organic matter, must be preferred. Sandy soils are preferred for early, and heavy soils for late types.

The cabbage is classified into six groups according to the shape of head. Its varieties can also be grouped as early, medium and late. Among the early (60 to 70 days), Copenhagen Market and Golden Acre are suitable for the plains. Among the medium (80 days), Enkhuizen Glory is

promising, while among the late (100 to 110 days), Danish Ball Head and Drumhead are suitable for the hills.

Sowing of seeds in the hills is done almost all through the year, although January-February and August-September are the main seasons. In the plains, sowing is mostly done during August-September or slightly earlier and the seedlings are planted during October-November. One ounce of seed produces roughly 1,500 seedlings and about 8 oz will ordinarily suffice to plant one acre. The seeds are sown in raised beds and the seedlings are transplanted 20 to 30 days later. In the plains they are planted on the sides of the ridges, which are placed two feet apart and the spacing between the seedlings is 1½ feet. On the hills, small pits are made for planting the seedlings. Before planting the seedlings in the pits, a small quantity of BHC or even ash is applied to serve as a repellant to the cutworms which cause a good deal of damage in the first week after planting. Since cabbage is a heavy feeder, the land selected for the crop should be fertile, failing which heavy applications of manure may be necessary. A basal dressing of 40 cartloads of well-rotted cattle manure is applied to the fields after the land has been brought to a fine tilth. In other countries, apart from the basal dressing, 1,000 to 2,000 lb of fertiliser mixtures are also applied. Nitrogenous manures are specially recommended and 150-200 lb of nitrate of soda is applied four weeks after planting and again an equal quantity is applied a month before the harvest.

In South India, about a month after planting, the plants are earthed up and manured. Regular watering and clean cultivation are recommended. Cultivation should be shallow, in order not to injure the roots which are near to the surface. Many roots grow within two inches of the soil surface. Irrigation should be adequate but not excessive, its frequency depending upon seasonal and soil conditions. In dry season for open soils, irrigation may be given once in two days and in ordinary soils twice a week.

Harvesting of cabbage should be done when the head is well-filled and hard. To protect the head one or two outer

whorls of leaves are also left. The average yield per acre is estimated at 4,000 to 5,000 heads—about 10,000 to 15,000 lb. The crop is ready for harvest in January-February in the plains and April to November on the hills. The duration of the crop ranges from $2\frac{1}{2}$ to 4 months depending upon the variety.

Cabbage sets seed in North India but in the South it rarely does so. It has, however been found that when crosswise slits are given at the top of the heads, the emergence of the floral axis is facilitated. One of the important precautions in attempting to produce cabbage seed is to see that the flowering and seed setting period is adjusted to coincide with the dry weather, *i.e.*, the period between January and March. For this purpose, the seed is sown in August and the seedlings are planted a month later. After the plants have formed heads, the mature heads are uprooted and transplanted again in another site in pits which are heavily manured in the months of December and January. The heads are then given crosswise slits through which the central axis appears and produces flowers, and the seed sets. Nearly 70 per cent to 80 per cent of the transplanted heads flower. After the plants flower, liberal applications of water and manure are made and the pods are harvested when mature. About 200 lb per acre of seed is obtained by this method. A maximum yield of 2 lb per plant has been obtained at Coonoor.

(2) CAULIFLOWER : The shortened and thickened parts of the flowers of this vegetable are used for culinary purposes. It is cultivated almost like the cabbage though its flowers are more sensitive to adverse conditions. Cauliflower, however, seems to require a more fertile soil than cabbage. Extremes of temperature often result in premature flowering which is termed as 'bolting'. Poor seed or dry weather at the time of heading may cause the same trouble. It requires a cool moist climate and does not flower well in the dry weather.

There are numerous varieties, the two popular ones being Snow Ball and Danish Giant. Two other varieties Autumn Mammoth and Magnum Bonum have done well under

Coonoor conditions. Blue Mountain and Pomocol are two other varieties grown on the Nilgiris. Pomocol is a strain built up from a single plant selection at the Pomological Station, Coonor. It is a late variety taking 4½ to 5 months and suitable for the autumn only. It bears very large heads weighing up to 8 lb under good conditions of cultivation.

On the hills, January-February and August-September are the main seasons for sowing. In the plains, the seed is sown in Agusut-September and transplanted in October-November. Four to six ounces of seed is enough to plant an acre at a spacing of 1½ to 2 ft either way. The treatment of the crop from the time of sowing up to harvest is generally the same as for cabbage. The crop is ready for harvest in 3½ to 4 months.

When the plants flower, it is advisable to cover the flowerheads as they develop by drawing the outer leaves over the head to keep off the sunlight. This helps to retain the white colour of the flowers, which if not sheltered may develop an unsightly tinge. This is a form of blanching. The shorter and thickened parts of the flower are called 'curds'. Delay in harvesting leads to a deterioration in the quality as 'ricing' *i.e.* discolouration takes place. In harvesting, the flower head is removed with a few lower leaves. Yield is about 4,000 heads per acre.

For seed collection, the best plants having firm heads of the desirable quality should be selected. Unlike the cabbage, cauliflower sets seed easily in South India.

(3) Knol-khol or Khol-Rabi : The turnip-like enlargement of the stem above the ground is the edible portion. It can be cultivated both on the hills and in the plains. It should be used before it becomes tough and stringy.

The knol-khol is transplanted after raising the seedlings in the nursery. Spacing is 8" in the row and 1½' between rows. Seed rate is 8 oz. The planting is done between January and August and the crop comes to harvest between March and October. Duration is two to three months. The treatment of the crop is similar to that of the cabbage. Earthing up is not done for knol-khol as the stem is liable to get damaged.

It has been suggested that a fortnightly application of liquid manure is helpful to the crop and prevents the edible parts of the stem from becoming rough and fibrous. Regular removal of old leaves is known to stimulate the development of the swollen stems. The crop is ready for harvest in about three months. The average acre yield is about 20,000 lb under copious irrigation and heavy manuring. The harvesting is done when the thickened stem is tender; when it becomes woody it loses its market value.

In some places the knol-khol seeds are dibbled directly into the field at 3″-4″ spacing and later thinned to 6″-8″ spacing. The plants which are removed in thinning are used as green vegetable. The directly sown crop is ready for harvest in about 45 days.

The colour of the stem is white, green or purple. The three common varieties are White Vienna with globular and light green head, Green Vienna and Purple Vienna with greenish white flesh and purplish head.

(4) Brussel's sprouts: The edible part is the buds or the small heads that grow in the axils of the leaves. These rarely attain a diameter of over two inches.

The cultivation is similar to that of the cabbage, except that a smaller spacing can be given. It does not require a rich soil or much manure, and the sprouts may become spongy under fertile conditions.

The plant can be propagated by seed and by allowing the buds or sprouts in the axils of leaves to shoot out and then removing them and planting them out.

The seed is sown in the nursery at a rate of 4 to 6 oz. The transplanting is done at a spacing of two to three feet either way or even less. The seedlings are planted between January and August and the life of the crop is more than one year. It is rarely grown on a field scale as it does not give heavy yields and is grown in the field borders in order to keep up a supply throughout the year. Sometimes the crop is removed after three months, when a large supply of sprouts has been obtained. The plants can, however, be kept even up to three years. After the third year, the heads become

small and the internodes become longer as the plants extend in growth.

Harvesting begins usually 3 to 3½ months after setting the plants. The sprouts are picked by going over the plants several times, before they open out. As the miniature heads are formed, it is advisable to cut off the leaves by their side, to an inch or so of the stem. This helps the sprouts to fill out faster and become larger. The first picking should not be delayed, for when the lower leaves begin to turn yellow the sprouts become tough, and lose their delicate flavour.

The winter crop is found to be the best, while the crop raised in summer is not so tasty. Of the varieties tried at Coonoor, Fill Basket has done well producing large sized, solid, green sprouts on plants 2½′ to 3′ high. The average yield per acre is about 5,000 lb.

VI. Root Crops

As a general rule all the root crops require a deep, well-drained and open textured soil of the sandy loam type. On shallow or heavy soils, these form undesirable fingered or forked roots.

(1) Beet Root: This can only be grown in the winter months in the plains viz., October-December. The beet root is very sensitive to acid soils and to extreme heat. The tops of the plants, before they become old can be used as a green vegetable. The important varieties are Early Wonder and Crimson Globe. The seeds are dibbled in lines at a spacing of 1′×1½′. Four pounds of seeds are used per acre. Transplanting is also practised in some parts but this tends to produce ill-developed roots. Ample supply of water, and shallow but frequent cultivation, are necessary.

Farmyard manure at 30 cartloads is applied as basal dressing. Commercial fertilisers are also applied by some. The crop is ready for harvest in about two months and the yield is about 10,000 lb per acre.

(2) Carrot: It is also a cool season crop in the plains. The carrot is not adapted to wet, heavy, clay or stony soils which result in misshaped roots. It is also often difficult to

obtain a good stand because the seedlings are delicate and slow growing. Much of this trouble can be avoided if carrots are planted only on deep, loose soils, which are free from clods, stones and trash.

The carrot is dibbled in lines at a spacing of 4″ in the rows spaced 1′ apart during September to December with a seed rate of 2 to 4 lb. The seeds are tiny and should be sown mixed with sand. There is also a practice of sowing the carrot seeds mixed with radish seeds. This is done in order to distinguish the lines in which the seeds have been dibbled. The carrot seeds are slow germinating and the plants are also delicate and slow growing. Therefore, when the radish seeds germinate, the lines can be distinguished easily. The radish is harvested before carrot plants grow up.

Heavy manuring and clean cultivation are practised. A succession of the same crop can be secured by sowing the carrot at intervals of two to three weeks. The carrot is not generally transplanted. Early varieties can be harvested in about 1½ to 2 months and late varieties in three to four months. Yield per acre is 8,000 to 10,000 lb. Early Nantes and Chantenay are the popular varieties.

(3) Turnip : This is another cool season root vegetable, seeds of which are dibbled in lines at 9″ in the row and 12″ between the rows with a seed rate of 8 oz. The crop requires a liberal dose of well-rotted cattle manure, supplemented by a top-dressing of fertilisers and frequent hoeing and weeding. The crop comes to harvest in 45 to 60 days. Yield is about 10,000 lb to the acre.

(4) Radish : Radish is also a cool season crop in all regions and in almost all types of gardens. The characteristic quick growth of radish makes it one of the most suitable associate crops. It is a hardy plant but thrives in sandy loams with good organic matter content. In heavy soils, the plants produce rough and ill-shaped roots.

The radish requires very little space. It is very rapid in germination and quick in growth. The small radishes require only three to four weeks to come to harvest, while the large

ones may take up to 10 weeks. The large varieties are more tolerant to heat and have a very firm pungent flesh.

A basal dressing of 30 cartloads of farm yard manure per acre is applied. Seed rate is 4 lb and the seed is dibbled in lines 6″ in the row and 12″ to 18″ between the rows. Sowings once or twice a week give a continuous supply of roots all the year round. Generally the seed is sown in June, October and February. The average yield is about 10,000 lb per acre.

Important varieties are Scarlet Globe, White Icicle, Scarlet Long and French Icicle. The roots are harvested before they become over-mature. Over-maturity is indicated by the roots becoming pithy, over-sized, fibrous and inedible.

VII. Indigenous tuber crops

(1) Elephant Yam: Elephant yam is a nutritive crop with a long keeping quality. The crop requires about 8 to 10 months to mature and is noted for its high yield. It is an exhaustive crop and can be grown in rotation once in three years in gardens or wet lands. Rich red loamy soils are preferred, while in black, clayey soils its keeping quality deteriorates.

The crop is planted in April-May and comes to harvest from December to April. The land is brought to a fine tilth by repeated ploughings, ranging from five to ten. Cattle manure is applied at about 50 cartloads per acre during the second ploughing and incorporated thoroughly during the subsequent ploughings. The yam is generally rotated with paddy, onions and ragi. The seed material is planted either in furrows placed $1\frac{1}{2}$ feet apart or in beds 7′ long and $3\frac{1}{2}$′ wide.

The selection and preparation of the seed material is important and should be done carefully from the last year's crop left unharvested for the purpose. The yam is cut into small bits in such a way that each bit gets at least a small portion of the rings, which are marked on the tubers. There are also projections, which are tender shoots. These are broken before planting as they do not give vigorous growth. An ordinary-sized yam gives about six to eight bits for

planting. The cut pieces are dipped in cowdung solution and this is said to prevent evaporation of moisture from the cut surface.

The cut pieces are planted on one side of the ridge at 1½ feet spacing in furrow method of planting or in small pits at the same spacing in the bed system. The pieces are planted in such a way that the sprouting region (the ring) comes into contact with the soil. About 3,000 lb of corms will be required to plant one acre. Sprouting takes place in about a month. Usually each bit gives rise to three shoots, one after another. A judicious method of irrigation, according to the needs of the crop, is adopted, for the first three months at intervals of 10 days, for the next two months at six days' intervals and twice a week thereafter.

The cultivation consists of about six weedings for the entire growing period. The crop is also earthed up as often as possible.

The crop is ready for harvest by the end of the eighth month, when the shoot portions of the plants begin to wither indicating the maturity of the crop. The harvesting operation consists in cutting away the shoot portion and lifting up the underground corms.

The yield varies from 30,000 to 40,000 lb. For seed purposes,the yams can be left in the field itself till required for planting. The lifted corms can also be stored in sand or paddy straw for seed purposes when they give rise to shoots. The weight of a single well-developed corm may be 10 lb and the average about 5 lb.

(2) Colocasia: This is another important root crop commonly used in Indian households. It thrives in warm, moist and shady situations and can be grown up to 8,000 feet above sea level. The plant grows to a height of 2-3 feet and forms a central tuber, which is 2-3 inches in diameter and also smaller side tubers. The stem originates from the central tuber, with leaves resembling those of the banana. There are two varieties—White and Black. The former is more largely grown. Its leaves and leaftips are green, while in the black variety the leaves and leaftips are violet. There

are two seasons for planting, June-July and February-March while the harvesting is done in January and July-August respectively.

Red loams and clayey loams are ideal soils for this crop. The crop is usually raised in June-July in garden lands and in February-March in wet lands.

From 25 to 50 cartloads of cattle manure are applied as basal dressing. The tubers are planted at a spacing of 1½ feet either way in furrows. The common seed rate is 650-750 lb of tubers per acre. The cultivation consists of occasional weeding and earthing up. Deep cultivation should be avoided as the tubers are produced side ways. About seven to ten irrigations may be necessary for the crop and top dressing with oilcakes or fertilizers is also done. The duration of the crop is about six months. The yield ranges from 5,000 to 7,500 lb per acre.

(3) DIOSCOREA ESCULENTA: The well-developed tubers of *Dioscorea* resemble potatoes in many respects, except for the numerous root fibres. In taste they are somewhat sweeter than the common potato. It is a cheap root vegetable and is favoured both by the rich and the poor.

Sandy loams are considered best for this crop which demands free drainage. The tubers are planted either in beds or on ridges. In the garden lands it is sometimes cultivated in rotation with other vegetable crops, like brinjal, bhendi, etc. It is also grown mixed with other vegetable root crops like colocasia, with setts of tapioca planted around plots of this crop. It is planted in May-June, the seed material consisting of mature tubers taken from the previous crop. Planting is done in rows 9 inches apart on square. About 1,500 lb of tubers are required for planting an acre.

The crop responds well to heavy manuring. Copious watering is also necessary. The crop receives about eight irrigations. The tubers begin to sprout in 10 to 12 days and in about six weeks the vines can be trained on to bamboo poles. The plots are weeded as often as possible. The duration of the crop is about eight months. When some of the older leaves turn yellow and begin to drop off, the crop is mature.

Sometimes the soil also cracks around the plants. The harvest is done in January by digging round the plants with a crow-bar. Each vine produces three to six tubers depending on the soil, season, etc. The yield is about 7,000 lb per acre.

(4) DIOSCORCA ALATA: This also yields edible tubers. Cultivation is similar to that of *Dioscorea esculenta*, planting being done in March-April. The crop matures in eight to nine months. The maturity of the crop is indicated by the cessation of all vegetative growth and change of colour of leaves from green to yellow and their shedding. The yield is about 10,000 lb per acre.

(5) TAPIOCA: This is aslo called as Cassava and is grown in large areas in Malabar and Travancore taking advantage of the heavy rains from June to December. Tapioca serves as a subsidiary food crop for the poorer classes, especially in lean years, being a substitute for rice to some extent. It is rich in carbohydrates.

It is propagated by stem cuttings and treated as an annual though it has perennial habits. The tubers of some varieties have small amounts of glucoside which with the decomposition of water sets free hydrocyanic acid, which is a poison. The glucoside present in cultivated forms is, however, generally negligible. In wild types, large quantities of glucosides are present and these are bitter. The glucoside is destroyed by cooking and the tubers are thereby rendered safe for consumption.

The crop is grown in tropical and sub-tropical regions and at elevations up to 2,500 feet, but it is at its best in lower altitudes. The plant can stand drought conditions to a certain extent. Open sunny situations are necessary for proper growth. Tapioca grows in a variety of soils but clayey and sticky soils do not permit full development of tubers.

The tapioca is propagated by stem cuttings called 'setts', which are obtained from the stems of the previous crop. These can be stored in shade up to three months. The stems are cut into pieces 6″ to 9″ long and the top portions, which are tender, are rejected. Generally cuttings from the basal portions give larger yields, while those from the apical end

produce lower yields. The setts are planted in a slanting position and 4″-5″ of the cuttings is buried in the soil. With 2½ to 3 feet spacing adopted either way, about 5,000 to 7,000 cuttings are required for an acre.

Being an exhausting crop, it responds to liberal manuring combined with heavy irrigation. Because of this, the crop that follows tapioca is generally poor unless it is manured properly. The crop is generally planted in June-July. In some places, planting is done in December-January, April-May and September-October depending upon the weather. The duration of the crop varies from 7 to 12 months.

There are a large number of varieties, differing in their duration, morphological characters, colour of the rind and flesh of the tuber, etc. The popular varieties are Malai-vellai, Valenca and Sundari-vellai. Planting of tapioca setts is done on ridges spaced three to four feet apart or in beds three to four yards square.

Cattle manure is usually applied at 10 to 20 cartloads per acre as basal dressing. Ammonium sulphate can also be applied at 100 lb per acre two months after planting. The crop responds well to liberal applications of potash in the form of wood ash or sulphate of potash.

Tapioca is grown as a rainfed crop in Malabar, the Nilgiris and South Kanara. In other places, it is an irrigated crop. About 15-20 irrigations in all may be required. Hoeing, removal of weeds and earthing up of the plants are the cultural operations required for the crop.

The crop is harvested after the tubers have fully developed. The maturity of the crop is indicated by the yellowing, drying up and shedding of the leaves. The soil at the base of the plant develops cracks due to the enlargement of the tubers underground. At this stage, a few plants are dug and the tubers are examined. If the tubers are fully mature, the soil does not stick to them and they do not snap easily. The tubers are then lifted after an irrigation has been given to make their harvesting easy.

The average yield in garden and dry lands is 12,000 and 8,000 to 10,000 lb respectively. The tubers do not stand

storage and should, therefore, be used within one week after the harvest. They are sold either fresh or boiled with salt. In view of the presence of glucoside in tubers, they have to be processed for destroying the glucoside and it is also advisable to supplement tapioca with small quantities of protein foods like fish, eggs, milk, meat, pulses, etc., to eliminate the possible ill-effects of the glucoside. In processing, the tubers are peeled, sliced and boiled or dried in the sun or fried in oil before use in culinary preparations. Starch, sago, semolina and flour are made out of tapioca tubers on a commercial scale in Salem and parts of Coimbatore district (Madras State).

(6) SWEET POTATO : The sweet potato is essentially a crop of the tropics. In Malabar and South Kanara it is found as a rainfed crop and in other parts as an irrigated crop. It is not able to withstand drought or stagnation of water. Deep loamy and sandy soils are considered to be the best for it. In very rich and clayey soils and under heavy irrigation, the vines produce rank vegetative growth and the yield of tubers is reduced. There are many varieties which can be classified according to the colour of the rind of the tuber and the texture of the flesh of the tuber.

The rainfed crop is generally planted in June and the irrigated crop in September-October. During the development of the tubers, water stagnation resulting from heavy rains should be avoided and the weather should be generally cool.

Sweet potato is usually grown after a cereal crop. Cattle manure is applied at 10 to 40 cartloads per acre. Planting of the vines is done on ridges spaced 2 to 2½ feet apart or in beds of 3 to 4 yards square.

Sweet potato is an exhausting crop and requires for its growth large quantities of nitrogen, phosphoric acid and potash. Heavy applications of potassic manures on the West Coast and complete fertilisers in other areas are carried out to increase the yields.

Semi-mature portions of the vines of previous crop serve as planting material. The crop is harvested in January-

March and the vines are then propagated in nurseries to give the cuttings for planting the next crop. The 'setts' are taken from the vines in the nursery and are planted in the main field with a spacing of 2-2½ feet between the rows and 9-12 inches between the setts. The central part of the sett is pressed into the soil, which has been irrigated, leaving the two ends exposed. The setts strike roots at the nodes and sprouts appear in 7-10 days. The setts are usually one foot in length and are prepared from the basal portions. About 15,000 to 30,000 setts are required for one acre and the cuttings taken from a plot of 8-10 cents are ordinarily sufficient to plant an acre.

The sweet potato requires about 10 to 20 irrigations during its life time. Two weedings, one after three weeks of planting and a second a month afterwards are given to the crop which is earthed up when the plants are 2½ months old. Another necessary operation is the lifting and turning of the vines frequently to break and disconnect the roots formed at their nodes. Neglect of this operation may affect the size of the tubers.

The crop is ready for harvest in 100 to 105 days of planting. The leaves turn pale and yellow and cracks develop in the soil at the base of the plants when the crop attains maturity. These indications are not, however, apparent in all varieties and in all soils. The mature tubers are comparatively brittle and the juice dries up quickly without any discolouration, while the surface darkens or gets greenish when the juice dries up rather slowly in the case of immature tubers. The skin of the mature tubers is not easily bruised, nor does it peel off easily. Soil does not stick to the mature tubers. The tubers should be harvested at the correct stage of maturity to get the best yields and quality. If kept longer on the land, the quality may be affected adversely and the tubers may be damaged by the sweet potato weevils. The harvesting is done by first cutting the vines and removing them and then lifting the tubers. An interval of about a week between the harvest of the vines and the tubers is believed to improve their taste.

The yield varies from 5,000 lb to 7,000 lb from rainfed and 8,000 lb to 10,000 lb from irrigated crops. In addition about 10,000 lb to 20,000 lb of vines are also obtained. When grown as green fodder, three to four cuttings amounting to 55,000 lb to 70,000 lb per acre can be obtained.

The tubers are used in different ways, raw, boiled, steamed, baked or roasted. They are also canned and dehydrated. Starch, syrup and alcohol are also made out of them in America. The green vines are a good feed for milch cattle. The tubers are a rich source of carbohydrates in a palatable form.

(7) Potato: The potato thrives best at elevations above 3,000 feet, with a cool, uniform temperature and evenly distributed moderate rainfall. The potato is grown largely in the hill ranges of the Nilgiris and also in the Mysore plateaux. In the plains of Mysore State, it is raised during the winter season between October-January. As only one crop can be grown in the plains, fresh seed has to be obtained from the hills annually.

A large number of varieties are in cultivation. Of those tried so far Great Scot is found most promising in the hills and Uptodate in the plains. There are three well-defined seasons for the Nilgiris—the irrigated crop in February to May; the main crop in March-April to August-September and the second crop from August to December.

In the Nilgiris, the seed harvested from the irrigated crop in May is used for planting the second crop in August-September and that harvested from the second crop in December-January is used for planting the main crop in March-April. The seed harvested from the main crop in August-September is used for planting the irrigated crop in January-February.

For obtaining good yields, the tubers should be sprouted before planting. For natural sprouting in storage at least 45 to 60 days are required in the Nilgiris. To quicken up sprouting, the tubers are treated with carbon di-sulphide at the rate of 1 oz for every 800 lb of tubers in air-tight containers. The carbon di-sulphide is kept in an open bottle

inside this air-tight container. By this treatment the tubers sprout within 10 days, and after ten days of rest they can be planted.

A well-drained, deep, friable red loam is best for the potato, which prefers a moderately acid soil. In the Nilgiris, potato tubers are planted 6″-8″ apart in furrows 15″-24″ apart. Whole tubers weighing 1½ oz to 2 oz and about 2 inches in diameter are used for planting. From 1,000 lb to 1,600 lb of seed tubers are required per acre.

The crop is heavily manured with farmyard manure and fertilisers. An average dose of three to five tons of cattle manure and 10 cwt to 16 cwt of concentrated manure mixtures are applied per acre. The cattle manure is applied in the furrows, the seeds are planted and then the fertiliser mixture is thrown and covered with earth. The intercultivation consists in giving two hoeings and earthing up. Many manure mixtures are manufactured by firms for the potato. These usually contain phosphatic, potassic and nitrogenous manures in various proportions. At the Agricultural Research Station, Nanjanad, a mixture consisting of 500 lb groundnut cake, 200 lb of sulphate of ammonia, 350 lb steamed bonemeal, 336 lb of concentrated superphosphate and 224 lb of sulphate of potash per acre has given promising results.

The crop matures in about three to five months depending upon the variety. The haulms (the aerial portions of the plant) completely die down when the crop is ready for harvesting, which is done with the aid of two-pronged *mammutty* forks. The tubers are allowed to dry to allow the adhering earth to drop off and to harden the skin to give a good appearance.

The potato seed is not fit for planting immediately after harvest. The seed has to be stored for about two to three months before its dormancy is over and it is ready for planting. The best way of storing seed is to spread it on wooden trays or racks two to three layers deep. Trials at the Agricultural Research Station, Nanjanad, have shown that medium sized tubers weighing 1½ or to 2 oz are the best for

planting. If seed supply is short, larger tubers can be cut into convenient bits and planted. The tubers should be cut longitudinally. The average yield is about 10,000 lb per acre.

VIII. Bulb crops

Onion and Garlic: These two crops are of commercial importance. The onion is commonly used both as a vegetable and a spice, while the garlic is mainly used as a spice in Indian cookery.

(1) Onion: The onion plant is a bulbous biennial herb, the edible portion being the swollen leaf bases that are packed tightly one over the other and surmounted on a flat stem.

In places, where the average annual rainfall exceeds 30 to 40 inches, the onion does not thrive well if grown in the monsoon period and can be grown only in the summer. The onion loves plenty of light and comes up well even in the cold weather. It yields better if the temperature is mild and the moisture is moderate in the pre-bulb formation stage, and the weather is bright and dry in the ripening stage.

Deep friable loams and alluvial soils are necessary for its cultivation. On light sandy loams, its bulbs become solid and heavy. The onion is grown in three seasons.

Monsoon crop	..	June to October
Winter crop	..	October to January
Summer crop	..	January to June

It can also be grown as an intercrop in the sugarcane and turmeric fields and fruit orchards. It is cultivated in rotation with coriander, paddy, cholam (jowar), ragi, groundnut, chillies and cowpea.

Onion varieties are known by their size, shape, colour and pungency of their bulbs and maturation habits. Commercially they are classified into two groups: (i) the big-sized bulbs of two to four inches diameter and (ii) small bulbs of half to one inch diameter. The big sized Bellary Onions have a mild flavour, are sweet in taste and are less

pungent when compared with the small sized onions. Under the second group come the commonly grown early maturing local varieties which form small sized bulbs in clusters. Pillu vengayam of North Arcot is a highly pungent variety of this group.

The onion crop is established in the field in the following three ways :—

(i) *By raising seedlings in a nursery and transplanting*

This is commonly done for the irrigated crop and chiefly for the Bellary Onion. The seed mixed with sand, is sown at 2 lb in six cents of nursery to plant one acre. Constant weedings and waterings are given to seed beds but stagnation of water should be avoided. The seedlings are ready for transplanting in six weeks, when they have grown to a height of 6″. They are transplanted either in 6′×4′ beds at 4″ spacing or on ridges spaced 1′ to 1½′ apart at a spacing of 4″ on either side of the ridges. They are planted straight and single. The tops of the uprooted seedlings are pinched off before transplanting.

(ii) *By planting bulbs directly in the field*

This method is adopted for the smaller bulbed varieties. The bulbs are dibbled on the sides of ridges or in beds. From 1,000 lb to 1,500 lb of small bulbs are required to plant one acre. Young bulbs not more than 1/2″ in diameter are used for planting. Larger sized bulbs if planted tend to flower early and result in low yields. The bulbs are planted at the same spacing as the seedlings and in three rows where ridge planting is practised—two rows on either side of the ridge and one on the top of the ridge.

(iii) *In North India the seed is also broadcast or drilled in the main field directly.*

The field is brought to a fine tilth and 25 cartloads of well-rotted cattle manure or compost are applied. Along with this, 200 lb of superphosphate and five cartloads of wood ash may also be applied per acre as this promotes better bulb develop-

ment. When organic manures are not available in large quantities, 400 lb of ammonium sulphate may be applied as top dressing a month after planting. When the land has been brought to a fine tilth and manure has been well mixed with it, the field is formed into ridges or beds and is planted.

Thorough and frequent intercultivation to remove the weeds is necessary. Generally two hoeings and four weedings are essential. Onions are not earthed up, as exposure to sun and air leads to a better development of the bulbs. Frequent irrigations when the weather is dry, at intervals of four to ten days, are necessary. The June crop receives five to six irrigations, the October crop 12 to 15 and the summer crop 15 to 20. The final irrigation is given two to three days before the lifting of the bulbs. Any neglect in irrigation in the bulb formation stage results in the cracking of the bulbs and a low yield.

Bulbs begin to form 2½ months after planting; flower formation is noticed as the maturity stage approaches. The flowering stalks should be nipped before the flower heads are formed to ensure a normal bulb development. The large sized type will be ready for harvest three and a half months after planting the seedlings or four months after planting the bulbs. The local pungent small-sized onions are ready for harvest in about three months. That the crop is mature can be seen by the leaves turning yellow from tip to base and finally dropping down. The harvest consists of uprooting the bulbs, cutting off the leaves and roots and removal of loose scales from the bulbs.

The average acre yield can be taken as 15,000 lb for large-sized and 7,500 lb for small sized varieties. A seedling planted crop gives about 25 per cent more yield than a bulb planted crop. The summer crop gives a lower yield but the bulbs keep well in storage. The yield is also low under rainfed cultivation.

For the production of onion seed, bulbs are selected from the harvested produce of the hot weather crop and are planted in October in a well-prepared and manured field with a spacing of 18". The crop produces seed profusely and is

ready for harvest in about five months after planting. The flower heads are harvested when they turn black. Since the ripening of the heads is not uniform, it is desirable to cut the heads at different stages before the seeds are shed. The heads are dried and threshed and the seed gathered. The seed does not remain viable for more than one season. An acre yield of 800 lb to 1,000 lb of seed can be obtained.

(2) Garlic: This is used primarily for seasoning. The garlic bulb comprises of a number of small segments called 'cloves,' which range from 6 to 10 and are enclosed by a thin sheath, white or light pink in colour. These are used for propagation. Garlic rarely flowers.

There are no distinct varieties of garlic but two types are met with in Bellary; these are known as 'Jawari Gaddi' and 'Rajalle Gaddi' and are of four and five months' duration respectively.

The planting material is the seed bulb or the 'clove'. It is usually planted in September-October as an irrigated crop. In parts of Andhra State, it is grown as an intercrop in young banana plantations and is also grown mixed with the brinjal. The cloves are either broadcast in beds or sown in furrows at a spacing of 4". About 300 lb of good sized bulbs are normally sufficient to plant an acre. The crop has to be carefully weeded and irrigated. The bulbs begin to develop at the end of the second month and the crop begins to mature from the fourth month after sowing. As in onions, the top leaves turn yellow and dry off when the crop matures. The bulbs are lifted, dried for a few days and then heaped up for a week before being prepared for the market. The yield is 4,000 lb to 6,000 lb per acre.

(3) Leek: The leek is a biennial which is chiefly grown as an annual for its long, blanched stems. It forms a thick, fleshy structure and is attractive in appearance with its silvery base and green top. The leaves are flat in contrast to the round ones of onion. It is eaten raw and is also cooked. The leek is started like the onion from seed, but it is usually sown in a trench so that the plants can be more easily blanched as the growth proceeds.

IX. Leguminous vegetables

(i) PEAS: The peas are sown in the hills from March to May or from August to September. In the plains, sowing from June to November is preferable.

Peas vary in size of seeds and in the presence or absence of wrinkles on the seeds. A distinction between tall and dwarf peas, and between canning and non-canning varieties, is also made. At Coonoor among several varieties tried, Duke of Albany, Early Giant and Peerless were found promising. There is also an ornamental variety called 'Sweet peas', which is grown for its beautiful flowers and the pods of which are inedible.

Picking of green peas may be commenced about 70 days after sowing. The pods of peas should be picked carefully by cutting their stalks and not by pulling them from the plant. For seed purposes fully ripe peas are picked, dried and stored carefully. The yield is about 2,000 lb per acre.

(ii) BEANS: Beans are divided into several classes—French or Kidney beans, Lima beans, Broad beans, Runner or Pole beans, Field beans, Soya beans, Cowpea, Cluster beans, etc.

French beans: These are also called bush or dwarf beans and are widely cultivated on the hills and to a small extent in the plains. They are rather sensitive to wet and chilly weather and to heavy dewfall. There are green and yellow podded varieties and the popular varieties are the following :—

Dwarf French and Canadian Wonder ..	Green
Bountiful Improved and Golden Wax ..	Yellow

Beans are sown from May to September in the plains and from April to June and again from August to September in the hills. The seeds are sown either in beds or furrows 18″ apart, with four to six inches from plant to plant, and a seed rate of 30 lb. When the plants are four to six inches tall they are earthed up. Weeding, hoeing and irrigation should be regularly done. The plants are also staked carefully. As soon as the first few pods are formed in the lower branches, the top shoots of the vines may be pinched off. This will check the upward growth and induce the pods to swell.

A bean crop is ready for harvest 45 to 60 days after sowing. The yield varies from 2,000 lb to 5,000 lb. The pods are collected when fully ripe for seed purposes and dried and stored.

Lima beans : Also called Butter or Double beans, these are less hardy. Cultivation is the same as for French beans. Burpee's Dwarf is the common variety.

Broad beans : Seeds are sown with a spacing of 2½ feet to 3 feet between rows and 1 foot in the row. Broad Windsor and Long Pod are the popular varieties.

Runner or Pole beans : Pole beans are sown usually in double rows about 12 inches apart, with a distance of about 5 feet between each pair of rows. The vacant space between the pairs of rows can advantageously be utilised for other short duration vegetables. Pole beans take about 60 days to yield pods. They are more prolific, have a longer season of fruiting and are more delicate than the French beans.

Soya beans : Soya beans are prized for human consumption in some parts of the world because of their high fat content. The flour can be used in baking and cooking.

There are a large number of varieties differing widely in the size and colour of seeds. Soya beans may be broadcast or drilled, with a seed rate of 10 to 20 lb per acre.

Sown in June-July they may yield up to 1,000 lb of grain as a rainfed crop. Under irrigation, over 1,200 lb per acre can be obtained. Before sowing, soya beans are sometimes inoculated with the proper strain of the nodule bacteria, *Bacillus radicicola* to ensure maximum growth and seed production. Application of phosphatic and potassic fertilisers is necessary, if the land is put under the crop as it is a heavy feeder. Except occasional weeding and irrigation, no special attention is necessary. The crop is ready for harvest in about five months after sowing.

Cowpea : In India, the cowpea is grown mainly as a pulse crop. The grains are made into flour and are used in different preparations. Young pods while tender can, however, be used as a vegetable. It is a good source of protein and vitamin B. In the United States of America, the cowpea is grown chiefly

for pasturage and green manuring. As a soil improving crop, it is of importance in crop rotation in vegetable cultivation. As a vegetable it is very popular on the West Coast, and is cultivated practically all through the year. The tender pods are as good as any pea or bean in flavour and taste.

There are many local varieties, differing in the length o pods, yield and quality of the tender pods. Pusa 419 is a good variety producing long (18″ to 24″), fleshy, light green pods of good quality.

The crop is generally sown under rainfed conditions, but under irrigation good yields can be secured. The seeds are sown from May to August. On the West Coast, the sowing is done in October-November under irrigation. The seed is dibbled on ridges three feet apart, with a spacing of one foot in the row at the rate of 30 lb. Within two to three weeks after sowing the plants are earthed up. As the plants cover the ground completely intercultivation is not possible.

The crop generally comes to harvest in about 10 to 12 weeks after sowing and the harvesting season extends over a period of about three months. About 3,000 lb of green pods per acre is the normal yield.

Field beans (Lab Lab) : Generally grown in backyards of houses, the green tender pods or mature seeds of these are used in culinary preparations.

A large number of local varieties with pods differing in size, shape and colour are found. Ten promising selections have been evolved at Coimbatore, viz., D.L. 259, 250, 692, 244, 229, 247, 389, 269, 338 and 1,428. D.L. 1,428 is suitable for being grown as a rainfed crop under field conditions, while the rest are the typical irrigated varieties suitable for backyard cultivation.

The main season for sowing is June to September. Sowings are also done in January. The seeds are sown in small pits at the rate of four to five seeds per pit. The pits are spaced 10 feet to 12 feet apart.

Some props should be provided for the vines to trail on or twine around in the early stages. A few days later, a *pandal* or trellis should be provided for the vines to spread out fully as

otherwise the yield is considerably reduced. A 10′ square *pandal* may be necessary for a pit with four plants. *Pandals* or props, however, are not necessary in the case of variety D.L. 1,428. For obtaining good yields, the garden varieties should be irrigated twice a week during the dry weather.

The vines start yielding four to five months after sowing. About 7,500 lb is the average yield per acre.

Cluster beans : Cultivated in all parts except in the hills, it is not a tasty vegetable. But the high-yielding capacity of this plant seems to be mainly responsible for its cultivation in almost all the backyards.

Two main varieties, one with about 4″ long pods and the other with pods about 2″ in length, are commonly under cultivation. The shorter podded variety is considered more tasty. In Coimbatore, six varieties, varying in the height of the plant, length of clusters, number of pods per cluster and length and quality of pods, have been selected. The variety C.P. 189 has a creeping habit, C.P. 78 and 380 are heavy bearers, while C.P. 387 and 51 are tender, non-stringy and are of better quality.

The plant thrives best in lighter soils, and is not very successful in the heavy black soils. July-August is the main season for sowing. The seeds are dibbled in lines, with a spacing of three feet either way, and a seed rate of 8 lb. The crop should be irrigated once a week during the dry season and weeded as required.

The tender pods become ready for picking 45 to 60 days after sowing and the harvesting period may continue, for about one to two and a half months. The average yield is from 4,000 to 6,000 lb per acre.

X. Solanaceous crops

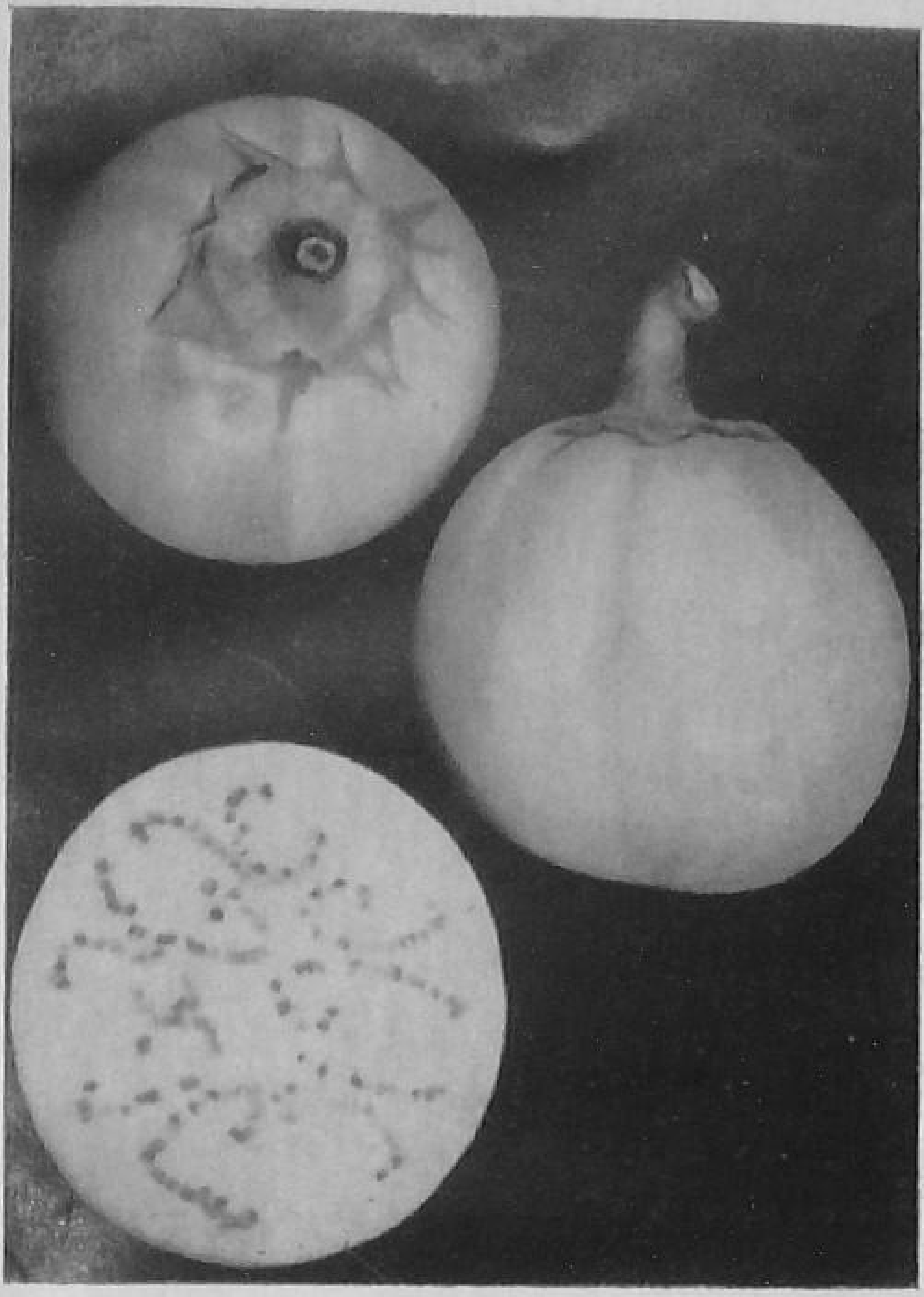
(1) Tomato : Though a recent introduction, the tomato is already very popular with all sections of people. Its cultivation is confined largely to the home gardens and the neighbourhood of big towns and cities. It is a rich source of vitamin C and is appetising both in the raw and cooked forms. It is adapted to varying conditions of climate and it is possible to grow

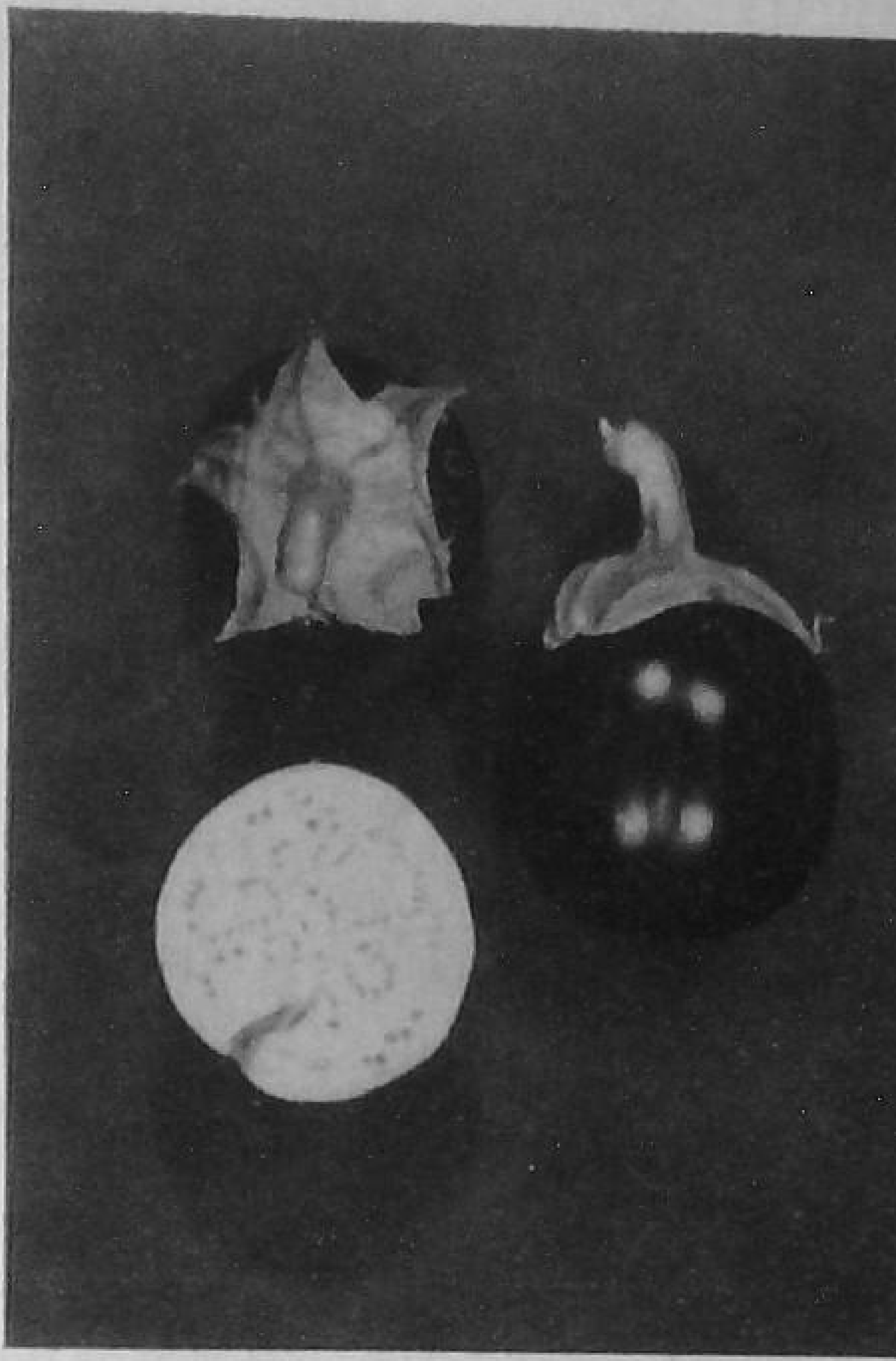
tomatoes all through the year. In the hills, they are grown best during the summer season whereas in the plains, three growing seasons viz., April-May; July-August; and November-December are recognised. There are a number of varieties under cultivation, chief among which are Best of All, Earliana and Ponderosa for the hills, and Ponderosa, Marglobe, Bonny Best, Oxheart and Pritchard for the plains.

The tomato requires a well-drained, light, fertile loam with a fair capacity for holding moisture for good production. For early crops, sandy loams are the best. About three to six ounces of seed is required for planting an acre. The seed is sown in lines in raised nursery beds and the seedlings are ready for transplanting in 35 to 40 days. The main field should be prepared thoroughly by ploughing many times and 15 to 20 cartloads of well-rotted farm yard manure should be applied and worked thoroughly into the soil. The seedlings are transplanted on the sides of ridges, at 18″ to 24″ spacing in the rows, which are two to three feet apart. The tomato responds well to the application of organic manures and artificial fertilisers. Top dressing with 800 lb of groundnut cake and 200 lb of ammonium sulphate in two equal doses has been found to be very beneficial in increasing the yield, as well as the size of the fruit. The crop has to be irrigated at least twice a week and requires to be earthed up twice and given four hoeings.

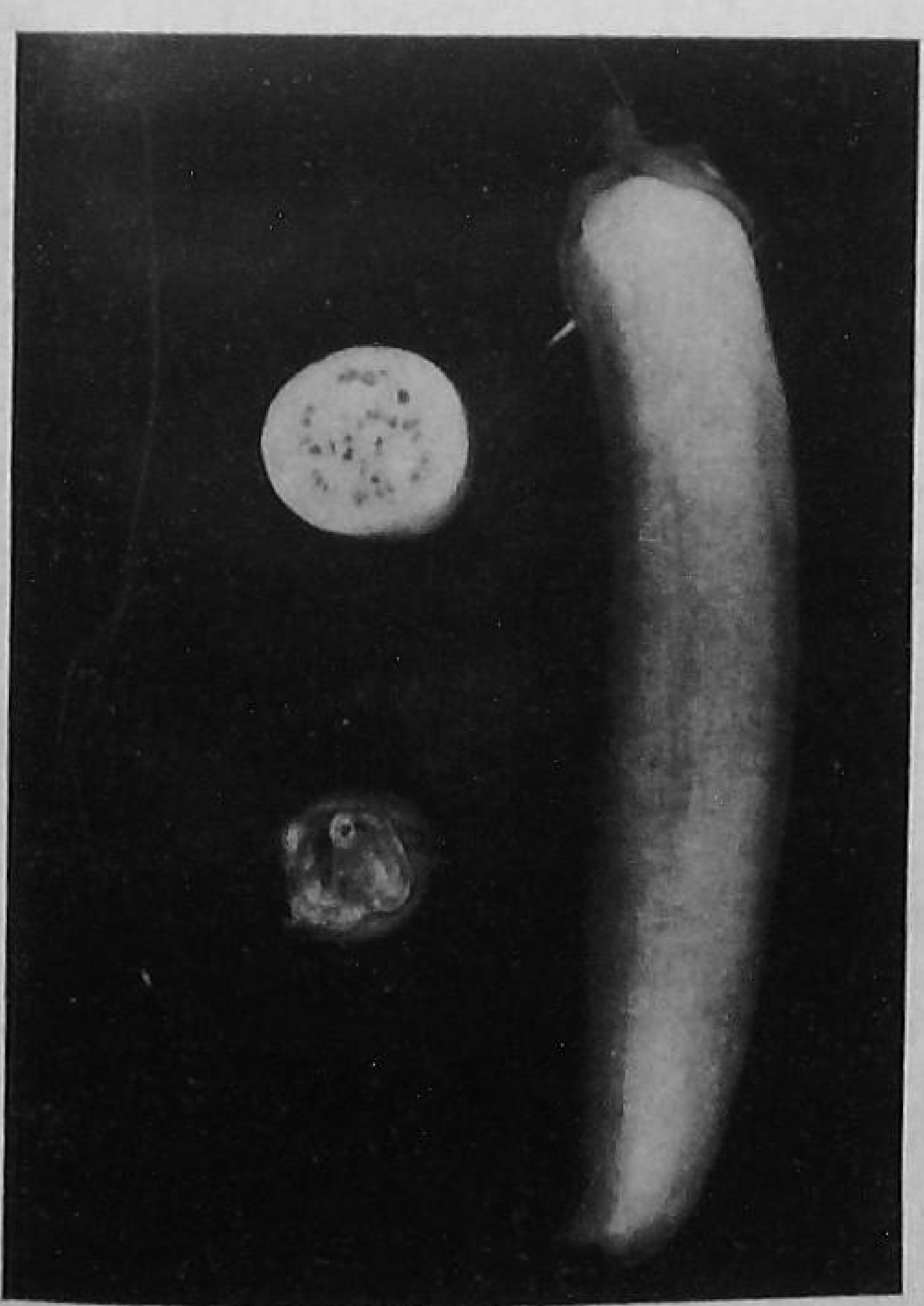
The most important cultural operations, however, are pruning and training. An ideal plant should have only one or two main stems standing erect with a few well placed lateral branches. The trained vines should be staked to bamboos, when they are about two months old. Pinching of laterals and the removal of the growing tips, when the plants are about six feet tall, should be attended to. About three months after planting, the fruits are ready and can be harvested twice a week for a period of 1½ to 2 months. The acre yield is about 8,000 lb to 10,000 lb.

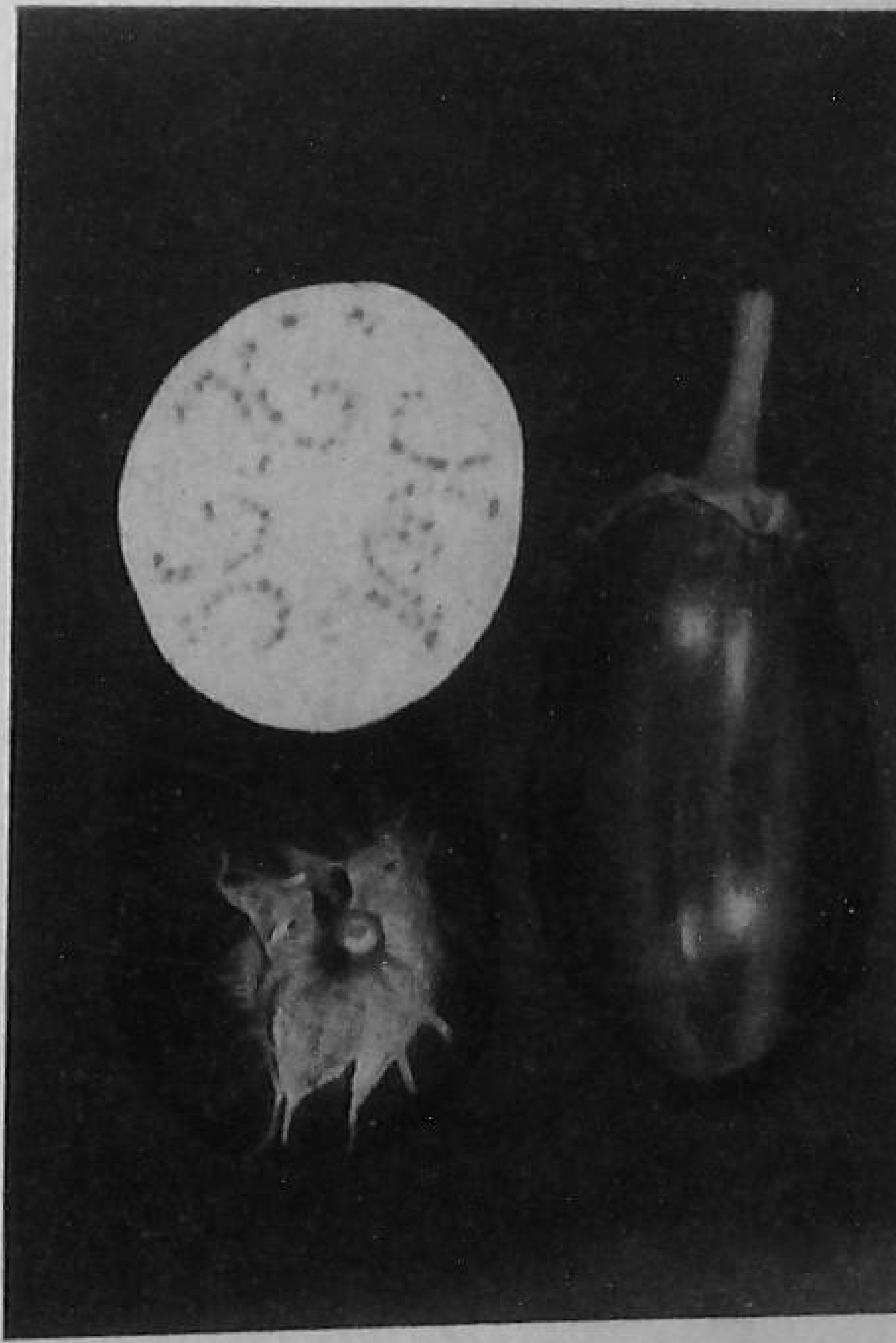
(2) Brinjal The most popular vegetable of South India is the brinjal. Adaptable to a wide range of climatic conditions, it is found in cultivation in one season or the other.





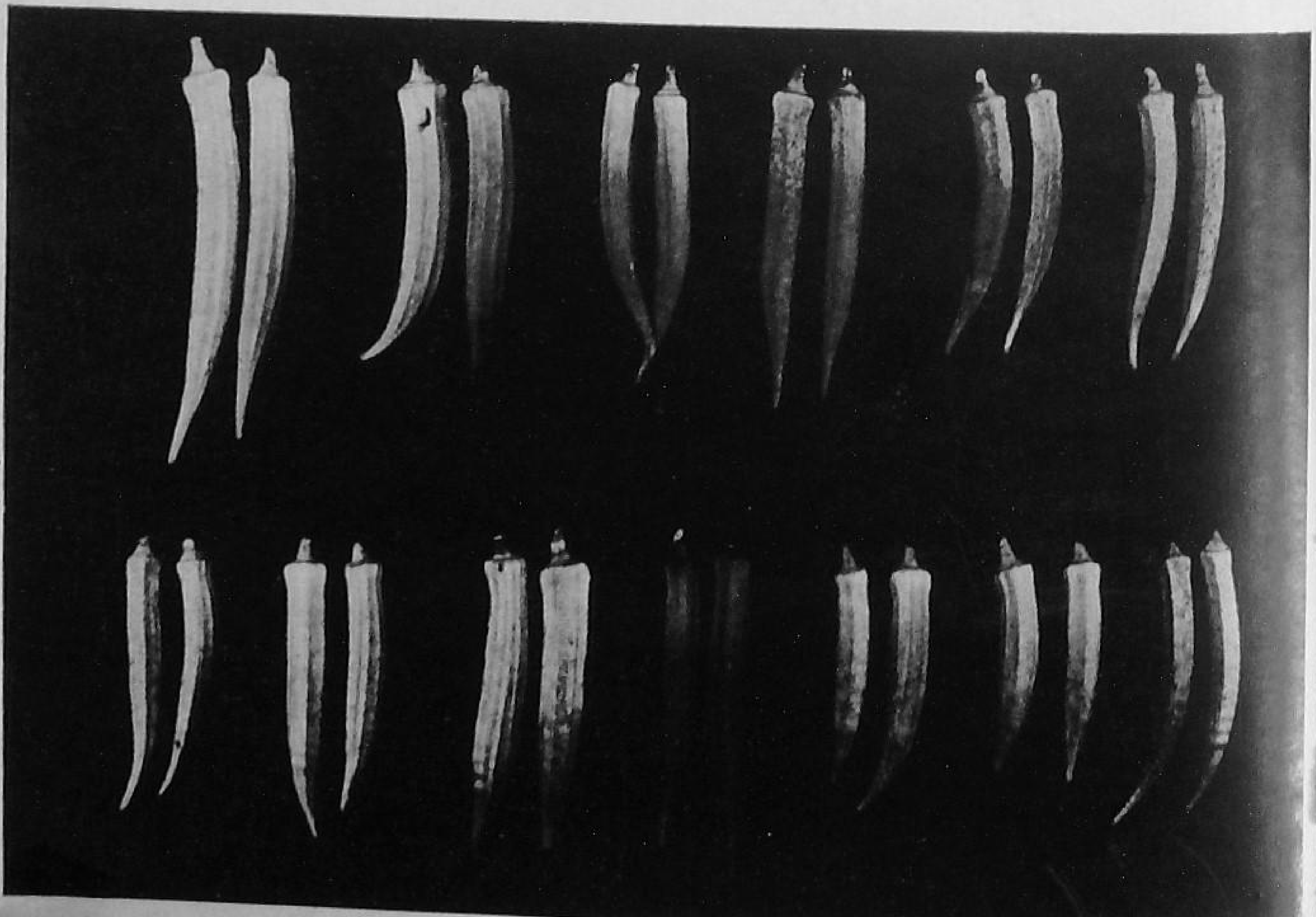
Varieties of brinjals





Vein-clearing disease of bhendi

Bhendi varieties



However, in the hills, sowings are confined to March-April whereas in the plains, two main seasons are August-September and February-March. The crop comes up well in almost all soil types, though for ideal production sandy loams are the best. There are a number of varieties based upon the colour of the fruit, fruit shape, duration, etc. However, the varieties generally recommended are Giant of Benares, Improved New York, Pekin Black Giant, Black Beauty and Mattigulla, which enjoy wide popularity in South Kanara.

The method of cultivation is similar to that of the tomato. Generally, three to six ounces of seed is required for raising seedlings to plant an acre. The seedlings are transplanted when 25 to 30 days old in well-prepared fields, in ridges two to three feet apart. The spacing between plants in the row is 1½ feet to 2 feet. The brinjal is a very gross feeder and is highly benefited by heavy applications of manure. Usually a basal dressing of 25-30 cartloads of farm yard manure or well-rotted compost followed by top dressing with 1,000 lb of groundnut cake and 200 lb of ammonium sulphate at the time of earthing up is given. The crop is earthed up twice and four weedings are given during its life. Regular irrigations at least once a week are necessary. The crop commences to yield fruits in two months after planting. The pickings are commonly done once a week. The yield of fruits varies from 6,000 lb to 15,000 lb per acre.

(3) Chilli: This is one of the ingredients very largely used in the Indian homes. It is said to be a rich source of Vitamin C, green chillies being considered to be even superior to oranges in this respect. There are two types—pungent and mild. The milder forms are characterised by large fruit size and are generally grown in the hills and near Tanjore. In the plains, the pungent types are grown and the seasons of cultivatoin are May-June, August-September and December-January. The method of cultivation is similar to that of the brinjal. Seedlings are transplanted when a month old in the field, with a spacing of 9″ to 12″ in the row and 1½′ to 2′ between the rows. Green chillies are ready for harvest in about three months after planting and ripe chillies can

be picked a month later. The acre yield ranges from 3,000 lb to 4,500 lb.

XI. Cucurbits

The vegetables coming under this group have been in cultivation in South India for a very long time. The cucurbitaceous vegetables require a moderately warm temperature and come up well under diverse soil conditions. They are generally not cultivated on a field scale, a few vines being grown in house compounds or market gardens. The land is ploughed well and pits are dug six to eight feet apart and well-rotted cattle manure at 20 cartloads per acre is applied. Four to six seeds are dibbled in each pit. Gourds like ash gourd, pumpkin etc., are generally allowed to trail on the ground, whereas snake gourd and bitter gourd are commonly trained on *pandals*.

Cucumber: Two types—slicing and pickling are in cultivation. Seeds are dibbled in rows three feet apart and one foot between the plants. At the time of earthing up, ash and fish guano are applied. Yield per vine is about five fruits. A number of types are found in cultivation on the West Coast such as Southekayi, Urvarkai and Keera. The season of planting on the West Coast is June-July and in Tamil districts March-April.

Pumpkin: There are several types of which the red pumpkin and ash gourd are important. They are consumed either green or used in the preparation of sweets. The two seasons for sowing the crop are January-March and July-August. The fruits are ready for harvest in four months and the yield, on an average, is three to four fruits per vine.

Bitter gourd: Immature fruits are green in colour turning yellow on ripening. Fruits are warty, oblong with eight to ten longitudinal ridges in between which there are a number of tubercular growths. The seed is planted in pits or in ridges and trained on *pandals*. The crop comes to harvest in three months. There are two types, one bearing long fruits and the other short fruits.

Snake gourd: Two types, one of ashy grey colour and the

other with green streaks on fruits, are known. The seed is planted in pits six to eight feet apart and the vines are trained on *pandals.* In order to induce the fruits to grow straight, small stones are tied to the tips. The fruits are ready for harvest in about three months of sowing. The season for sowing is July-August.

Ribbed gourd: Two types, one bearing long fruits, the other short fruits, are commonly grown. The cultivation of this crop is similar to bitter gourd. The fruits have to be harvested when fairly tender; otherwise they become stringy and inedible.

Bottle gourd: There are two main varieties bearing long and round fruits respectively. Both varieties are used for culinary purposes when green and tender.

XII. Miscellaneous vegetables

Bhendi or Ladies Finger: Bhendi is one of the most popular vegetables found in cultivation all over South India. The plant is very hardy and can be grown in any situation except at elevations above 4,000 feet. Though cultivated throughout the year, two main seasons for its cultivation are February-March and June-July. There are a number of promising varieties differing in the shape and colour of the fruits and the stature of the plants. Some of the promising varieties are Long Green, Indian Bhendi, Montein, White Velvet and Panchadari. The crop thrives well in loamy soils which have been heavily manured. Ridges are formed two feet apart and the seed is dibbled on the sides of the ridges at a spacing of 1½ feet to 2 feet. About four to six pounds of seed is required per acre. Liberal applications of phosphatic manures are very beneficial to the crop. The crop has to be regularly irrigated once or twice a week and receives two to three weedings. The fruits are ready for picking six to eight weeks after sowing and continue for three to four weeks. Average yield per acre is 4,000 lb to 5,000 lb.

Chapter IX

PESTS AND DISEASES

A. Pests

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
Brinjal			
Fruit and shoot borer	Boring into the top shoots when the plants are young and into the fruits when they start bearing	Remove attacked fruits and shoots and spray Calcium arsenate and lime (1 : 4) or Lindane (1 lb in 13 gallons) as a preventive measure	A common pest of brinjal fruits; Caterpillar is pink in colour
Stem-borer	Bores into the stem and often kills the plant	Pull out and destroy first attacked plants as a preventive. Chemical control same as above	Appears generally in old gardens where the plants have completed their yielding season
Epilachna beetles	The beetles and the grubs scrape the green matter from the leaves	Spraying and dusting with Calcium arsenate mixed with lime (1 : 4)	Round spherical spotted beetles scraping the leaf surface. Found in all stages. Also found on some Cucurbits. This is probably the most common pest of brinjal

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
Mealy bugs	Colonies of these adhere to the growing shoots and suck the sap. In serious cases the plants dry up	Spray Folidol (1 oz in 12½ gallons of water)	Biological control by using the Australian lady bird predator is also being tried
Lace wing bugs, aphids, mites	Often these insects appear in colonies on the tender shoots and leaves and suck the plant sap	Spray HETP (1 oz in 6¼ gallons of water)	
LADY'S FINGER (Bhendi)			
Fruit borer	Caterpillars bore into shoots and fruits. The fruits become unfit for consumption and often get twisted in appearance	Preventive methods alone practicable. Clip off shoots when they are attacked and pick off early attacked bolls to prevent further multiplication. Periodical application of Lindane may also be done as a preventive	

Insect	Nature of injury done to plant	Sugestions for control, if any	Remarks
Leaf hopper	Infests plants in swarms and sucks up plan sap	Spray DDT (1 oz in 3 gallons) or dust 5% HETP or spray (1 oz in 6 gallons) will also give effective control	A small and active hopper; found also on cotton
Leaf caterpillars	Defoliate the plants	Dust Lindane	There are several varieties of these creatures attacking bhendi
SWEET POTATO			
Sweet potato weevil	The vines are bored by the grub and damaged badly	No effective remedy known; attacked vines and tubers to be destroyed to check spread; growing of deep rooted varieties and leaving the field fallow for a season or two will give relief. Recent experiments have shown that the application of Aldrin and Dieldrin to the soil as well as to the plants periodically gives much relief against the pest	An ant like blue and red weevil, a major pest of the crop, found both in the field and in the stored tubers

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
Potato			
The tuber borer	The caterpillar burrows into the tuber and damages it badly. It is more a pest of tubers in the store than in the field	Only preventive methods effective: dust Lindane 0·65% lightly on surface of stored bags (at 1 lb per 800 lb); if in field, incorporate DDT or Lindane in furrows. Spraying Dieldrin also effective	Often a serious pest in the Nilgiris
Cutworms	Feed on the foliage	Dust DDT 5% dust	Often serious
Moringa			
Hairy caterpillar	Defoliates the plants completely within a short time	Burn the swarms of caterpillars with a lighted torch or spray them with Fish-oil Resin Soap	The caterpillars often collect together in thousands and rest on the plant stem; they are hairy and irritating to touch
Pumpkins, Cucumbers, Gourds etc.			
Pumpkin leaf-beetles	Beetles feed on the foliage	Dust the plants with Calcium arsenate mixed with lime (1 : 4)	These are active insects and sometimes cause appreciable damage to leaves of gourds, melons and pumpkins

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
Fruit flies	Maggots bore into the fruit pulp and damage the same	Destroy badly infested fruits as a preventive measure against multiplication of the pest. Spraying of plants with a sweetened poison to kill the flies may also be tried in bad cases. The soil at the bases of the plants may be dug up to kill pupae inside	Often bad on bitter gourds and melons. Found also in mango and other fruits
CHILLIES			
Chillies thrips	These minute insects lacerate the leaf surface and cause severe curling of the tender shoots and leaves; affected plants appear sickly	Dust or spray BHC	
ONIONS AND GARLIC			
Onion thrips	The insects remain in the axils of leaves and feed on the plant sap	Spray Lindane	The presence of white silvery patches on the leaves will indicate the damage

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
TOMATO			
Tobacco caterpillar	Caterpillar feeds on leaves and bores into fruits	Dust or spray DDT as a preventive. Destory attacked points so as to check multiplication	Sometimes found together with the gram caterpillar (*Heliothis*) boring into tomato fruits
Epilachna beetles	Grubs and beetles feed on the foliage	Same as for brinjal epilachna (see under brinjal)	Sometimes bad on tomato
Mealy bugs	Millions of these small creatures cover the plants and suck the juice	Spray HETP (1 oz per 6¼ gallons) or Folidol (1 oz per 12½ gallons). (The insecticides should be used with the usual precautions)	Whole plants are often covered with colonies of these white cottony insects
CABBAGE, CAULIFLOWER, RADISH, MUSTARD etc.			
Cutworms	Feeding on foliage	Dust DDT 5%	Sometimes bad on the hills

B. Diseases

Crop	Disease	Control measures
BHENDI	Vein clearing or Yellow Vein Mosaic	Roguing of virus affected plants. Keeping the fields and neighbourhood free of all weeds and wild hosts of the virus. Spraying the crop with an insecticide (BHC or DDT) to control the insect vectors
	Powdery mildew	Dusting the affected plants with finely powdered sulphur
	Leaf spot	Spraying the foliage with 1% Bordeaux Mixture or other Copper fungicides
BRINJAL	Little leaf	Roguing of virus infected plants soon after their appearance. Removal of all Solanaceous plants in the neighbourhood of brinjal fields and control of insect vectors by the application of suitable insecticides
	Wilt	Removal of wilt affected plants. Drenching the soil with 1% Bordeaux mixture or Cheshunt compound at fortnightly intervals
	Damping off	Avoidance of excessive moisture in the nursery and drenching the soil with 1% Bordeaux mixture or Cheshunt compound
	Leaf spot	Spraying with 1% Bordeaux mixture or other Copper fungicides
	Powdery mildew	Dusting with finely powdered sulphur
	Rust	Dusting with finely powdered sulphur

Crop	Disease	Control measures
TOMATO	Early blight	Spraying the foliage with 1% Bordeaux mixture or other Copper fungicides. About two to three sprayings may be necessary depending on the severity of the disease and weather conditions
	Fruit rot	Spraying with 1% Bordeaux mixture. Care should be taken to prevent the fruits coming in contact with soil
	Wilt	Drenching the soil with 1% Bordeaux mixture or Cheshunt compound at fortnightly intervals
	Virus diseases	Roguing of infected plants right from the early stages. Removal of all Solanaceous and other host plants and control of insect vectors by the application of suitable insecticides. Avoidance of contact between healthy and diseased plants is also necessary
	Damping off	Spraying the nursery with 1% Bordeaux mixture at weekly intervals
	Leaf spot	Spraying with 1% Bordeaux mixture or other Copper fungicides
CUCUR BITS	Powdery mildew	Application of sulphur to the soil round the base of the plants. Foliage application of fungicides should be avoided
	Mosaic	Roguing of affected plants and selection of disease-free seed from healthy plants
PEAR	Powdery mildew	Dusting with finely powdered sulphur at the rate of about 25 to 30 lb per acre
	Leaf spot	Spraying with 1% Bordeaux mixture or other Copper fungicides

Crop	Disease	Control measures
Lab Lab	Rust	Removal of heavily infected leaves and dusting the foliage with sulphur
	Mosaic	Roguing of affected plants
	Powdery mildew	Spraying with 1% Bordeaux mixture as a preventive spray
French Bean	Anthracnose	Spraying with 1% Bordeaux mixture and selection of disease-free seed. Seed treatment with seed dressings like Spergon may be adopted.
Cluster Bean	Powdery mildew	Dusting the foliage with finely powdered sulphur
	Leaf spot	Spraying with 1% Bordeaux mixture or other Copper fungicides
Cabbage	Club root or Finger and toe disease	Avoidance of diseased seedling and treatment of seedlings with 0·1% Mercuric chloride solution prior to planting. Drenching the soil with 0·05% Mercuric chloride at the rate of half a pint per planting hole is also recommended. Provision of good drainage is also helpful. Crop rotation avoiding Cruciferous plants is also suggested
	Boron deficiency	Application of boric acid to the soil at the rate of 5 lb. per acre or spraying the foliage with 0·2% boric acid is effective
	White rust	No control measures are taken
	Leaf spot	Spraying 1% Bordeaux mixture
Turnip	Water core	Application of boric acid to the soil at the rate of 5 lb per acre
	White rust	No control measures are known
Onion	Blight	Spraying the crop with 1% Bordeaux mixture or other Copper fungicides

PART III

FLOWER GARDENING

CHAPTER I

INTRODUCTION

Flowers and ornamental plants are universally admired. In India flowers are specially prized not only for decoration, but also for use in offerings, in religious functions and during all types of festivities. Ornamental gardening makes an appeal to persons in every walk of life, and offers continuous pleasure all through the year. The charm of flower or ornamental gardening lies not only in the universality of its appeal but also in providing a source of interest to persons irrespective of class, creed or colour. A delightful garden has a soothing influence and the healthful aspects of gardens and parks are now recognised all over the world. No urban plan today can be said to be complete if adequate provision has not been made for parks and gardens. One of the purest forms of human pleasure is, therefore, rightly claimed to be associated with gardening. Devotion to gardening as a hobby may therefore, be deemed to be something that will tend to ennoble the human spirit, besides adding to the beauty of the landscape and bettering the health of the people. The love of flower and plants is latent in all human beings but it has to be fostered and helped by an understanding of the principles of ornamental horticulture. Only then will our countryside and urban areas benefit by an all round development of ornamental plant wealth.

Chapter II

PLANNING THE GARDEN AND LAY-OUT

Gardens cannot be deemed as very beautiful if they are all planned according to a set pattern. Uniformity or design may have its uses in laying out a town or village, but not in laying out gardens or parks. One of the greatest advantages of gardening is the opportunity it offers for the expression of originality and initiative. The same land if laid out by different persons may present a beautiful sight in itself, though one design may be better than another in producing the final aesthetic effect. Anyone can suggest a design for a garden, but a good design is only possible when the designer has a good knowledge of the practical side of gardening and understands the characteristic features of the innumerable plants that will go to make the garden. Planning a garden, therefore, presupposes a good knowledge of plant life, its cultural requirements and the ornamental features of each plant.

There are many ways of arranging a piece of ground whether it be for pleasure or for profit. A study of the various designs, though not adequate by itself, will nevertheless help in giving an idea of the vast possibilities. The formal gardens with geometrical designs have no doubt been popular during some periods of history and in some places. But they have been gradually giving place to the natural or landscape gardening. Despite these changes, formality to some degree or other is inevitable in a garden. But there is no set rule or fashion one must follow. Perfect freedom for everyone to adopt any features which he has found best in any system of gardening, provides the keynote of ornamental gardening as it is commonly practised today.

It is recognised that a garden is a work of art and not a mere collection of plants. For the skilful arrangement and disposition of plants over the available area, artistic taste and intimate knowledge of the science and practice of ornamental

A fine view
of an ornamental garden

Flowers in bloom

Broad roads around traffic islands, lawned strips, clipped hedges and ornamental trees lend charm to a park

plant culture are of greater importance than an inelastic garden plan or design.

To a great extent the arrangement and lay-out of a garden depends upon the soil, the area, the size of the house, the nature and quantity of water supply, the extent of interest and time that the owner or others can bestow.

Subject to the foregoing, the following brief points on some of the more important styles or designs of gardening are presented :

1. The natural style, sometimes also called the landscape style, is conceived with the object of imitating nature. In this provision is made for large open lawns bordered by clumps of shady trees and shrubs, which form the main features.
2. The aim of the formal, geometrical or the symmetrical style, is to bring out harmonies and contrasts in colour, generally with one part resembling another part. Such gardens are found in front of some famous monuments or public buildings.
3. A free style gardening combines the good features of both the types mentioned above, by dispensing largely with the formality of the latter and being flexible enough to meet the needs of almost every situation. In this, full use is made of the existing trees or other permanent fixtures, each of which is improved by using plant life in an appropriate manner.

Whatever the design that is adopted, it is necessary to have a central theme for the garden. In a home garden, the house may well be such a theme, in front of which a lawn can be laid out and the plantings may be adjusted to add colour and complete the picture. Flowers or plants with bright coloured foliage are very effective, for instance, against the background of green foliage. Smaller flowers look attractive in such a setting when arranged along the borders or by the corners of the residence, in front of porches or by adjustment in grooves in the landscape design. But it is essential to see that scattered effects are not produced and the objective of

a full picture with harmonious effects is not lost sight of. The chief concept of good gardening, therefore, lies in maintaining a proper balance and a sense of unity among the various components.

Some of the undesirable features which should be avoided are the formation of paths that lead nowhere and are without any utility, isolated pergolas which break the rhythm or balance, setting up rockeries in a flat ground or amidst lawns, an excess of statues or other garden decorations, mixing up an early flowering or late flowering plant in the same bed, the predominance of a certain group of plants in the garden, overcrowding of plants, planting of large trees which sometimes dominate a low house, excessive similarity in the design of beds suggesting monotony, etc. A perfect garden depends upon so many subtle considerations that it is difficult to create it through text-book designs, but when once a good garden is established, its beauty is appreciated by all. A skilled gardener has to analyse the features that have contributed to the success of such gardens and introduce only such features as are appropriate for the land which he has to shape into a garden.

Chapter III

CLIMATE AND SOILS

For ornamental gardening there is little to be done by way of selection of a site. In most cases what is required is merely to make the best use of an available site. The climate of the locality cannot be altered appreciably except by very expensive arrangements. Glass houses, pot houses or green houses are the costly methods devised to grow plants under controlled conditions of climate. Most of the people, however, have to take the site with its climate and soils as they exist, exercising their skill only towards the improvement of the soil, to some extent.

It is well-known that climate regulates the growth of the plants and delimits the places where each plant can prosper. Thus, the plants that thrive in the plains of South India are not all the same that grow in altitudes of about 2,000 feet above mean sea level; which again differ greatly from those that can be grown on elevations of about 6,000 feet above mean sea level. The cooler climate on the higher elevations renders it possible to cultivate many a plant which can never be grown in the warmer plains. Ornamental gardening in the hills, therefore, is of a different character with plant components which will be quite strange to a gardener in the plains.

In the plains, also, there is some difference in the character of gardening practised from tract to tract. Under dry conditions we usually find scrub jungle or thorny vegetation, which are adapted to drought conditions. On the other hand, in the heavy rainfall tracts, such as the West Coast, we find luxuriant tropical vegetation. There are several other zones coming between these, where the plant life differs from either of the two extremes. A knowledge of the plant life adapted to each of the climatic zones is of great value to the gardener.

In a given zone, the climate naturally varies from season to season. In the hills, the garden vegetation in winter is

quite different from that possible in summer. In the plains, too, the type of gardening found during the summer months cannot be the same as that found during the rest of the year. The period and extent of rainfall, as well as the availability of water for irrigation, therefore, determine to a great extent the nature of gardening in the plains.

Broadly speaking, the soils that are met with in the southern parts of India can be divided into heavy clay, loamy, sandy and gravelly soils. Though the colour and character of these soils may vary to a great extent, the above classification can be generally adopted as providing an indication of the nature of soil treatment that is necessary for gardening. The clay soils are highly retentive of water leading to ill-drained conditions during heavy rainfall periods. They are difficult to cultivate and in periods of drought are liable to crack badly under some conditions. Addition of sand, abundant organic manures or green leaf will improve the drainage. Open or covered drains to let out excess of soil moisture are also useful for improving these soils.

The loamy soils are generally considered ideal for gardening, while the sandy soils and to a greater extent the gravelly soils are very porous having generally poor fertility and permitting the loss of water and plant food through leaching. Application of water at more frequent intervals and plant foods, like leaf mould, and other forms of organic matter or manure, are necessary in such soils for successful gardening.

Depending upon the acidity or alkalinity of soils, soils are assessed for their suitability for plant life. Generally speaking, soils on the West Coast under heavy rainfall conditions are on the acid side, while in the arid zones they are either neutral or alkaline. Along the coast, soil strips with high content of sodium salts are also met with. Analysis of soils by a competent chemist, both for physical and chemical content, is a safe procedure to adopt before the site is finally selected for gardening. Even where there is no choice left to the gardener, a soil analysis makes it possible to demarcate the existing sites, so that each section may be devoted to the type of gardening for which it is best suited.

Chapter IV

PROPAGATION

The method of propagation of ornamental plants does not differ in many respects from that adopted in other branches of horticulture. It is true that each plant may respond to a particular method better than another. But the actual method does not vary very much from plant to plant. As already stated both sexual and vegetative methods of propagation are employed in ornamental gardening, as in other fields of horticulture. The collection of seeds between seed-propagated ornamental plants may vary to some extent, as well as the process of raising seedlings. But in broad principles there is no great difference. As in all other plants, the ornamental gardener has to secure the best seed and preserve it carefully till required for sowing. In some cases, as in Balsams, the seed collection has to be done before the fruits burst. All seed requires to be cleaned and dried in the shade for a few days and preserved in a cool dry place in packets, bottles or tins with lids on. A little of Naphthalene powder or crystals of para-dichloro benzene helps in protecting the seed from the insects. Germination tests, as suggested for vegetables, are useful prior to sowing. The seed is sown either in beds, pots or pans. In certain cases, the seed coat is too thick to permit sowing directly. Canna seed belongs to this category and must be soaked in warm water and kept moist for a couple of days before sowing. In seeds with harder coats, filing of the coat or treatment with a strong acid for a short time may be necessary. Generally, the seed beds, which may be prepared more or less on the lines mentioned under vegetables, are made with top soil mixed with sand and sifted leaf mould up to a depth of six to nine inches. The seed is either broadcast, as in the case of Aster and Phlox, or sown by hand, as in the case of Balsam and Nasturtium, with a definite spacing and is covered with a mixture of fine soil or powdered leaf mould

or a mixture of both, roughly to equal the thickness of the seed. Sometimes a layer of coarse sand is spread on the top of the seed bed after sowing, with or without the addition of some charcoal dust which may help in keeping off certain fungal attacks. The watering of the bed should be done with the help of a rose can, giving a very fine spray of water which will not dislodge the seed in the bed. Temporary sheds, with some improvised roof covered with leaves or *thatties* of bamboo, are necessary in the beginning, but these are gradually removed as the seedlings get hardened. Thinning out of the seedlings in beds is done occasionally so that only robust seedlings are retained for final transplanting. It is common to 'prick' or transplant the seedlings from bed to bed, to make them hardy and encourage growth of fibrous roots.

For sowing delicate seeds, such as those of Cineraria and Begonia, pans or shallow pots or boxes are used. These pans or boxes may be about four to five inches high with a diameter of ten to fifteen inches at the top. They are provided with one or more drainage holes at the bottom. Over each of these holes is placed a curved piece of pot (crock) with its concave side down in contact with the drainage hole, in order to permit the surplus moisture to escape. A few more crocks are thrown in, over which the following are put in the order mentioned—one or two handfuls of coarse sand; a soil mixture comprising one part each of sand, garden loam and two parts of sifted leaf mould. After this has been levelled and lightly pressed, a light watering is given with a rose can, and when the water has drained, sowing can be taken up. Fine seeds have to be sown after mixing them with fine sand so as to secure even distribution. Very fine seeds, like those of Begonia, are merely mixed with sand and sown without any further covering above, while with larger seeds a layer of sand or loose soil may be thrown over to cover the seeds. After sowing, watering may be done as usual with the aid of a fine rose can, but in the case of very tiny seeds the pan itself is allowed to stand in a basin of water to permit it to rise through the drain hole to the surface of the soil within the

pan just to moisten it. A glass piece is used generally to cover the pan and the pan is kept under shade. After germination, the glass piece is removed and the pan is slowly brought into the open. If kept in the shade too long, the seedlings tend to become lanky.

Thinning has to be done as in beds by pulling out seedlings from crowded parts. Pricking may be done when the seedlings develop the first pair of leaves or a little later. For this first transplanting it is usual to have a slightly richer soil to which well-decomposed and finely powdered manure has been added in liberal quantities. For pricking, the soil should be neither too moist or dry so that each individual seedling can be gently removed without root damage. Transplanting more than once is done in the case of some plants like Asters.

There are many plants which are propagated both by seed as well as by other vegetative methods. Seed propagation, however, is not used in those where cuttings, suckers or other methods of vegetative propagation are convenient or easy, except when new varieties are intended to be produced. All these methods of propagation by cuttings, whether of soft wood or hard wood or leaf, or by the more elaborate methods such as layering, gooteeing, budding, grafting and also by such methods as by division of suckers, offsets or rhizomes etc., have been dealt with in Part I and these may be of general interest to all interested in flower gardening with such modifications as are necessary to suit each type of plant. Among the common ornamental plants, Coleus is propagated by soft wood cuttings, Croton by hard wood cuttings, Poinsettia by ripened wood cuttings, Jasmine and Oleander by layering, Begonia Rex by leaf cuttings, Chrysanthemum, Michaelmas Daisy and Amaryllis by division of suckers. Amaryllis and allied plants are also propagated by bulbs (offsets), Canna by rhizomes, certain ferns by aerial off-sets which arise on their fronds, and Agaves by bulbils which are young plants arising from their flower stocks. Grafting and budding are common with roses and with many herbaceous plants and climbers.

Chapter V

PLANTING

The planting of all plants is best done in the evenings and on cloudy days. With annuals, which are sown in seed beds or pots, sowings are generally done several times at short intervals, so that the seeds are not wasted by any unfavourable feature such as a sudden downpour of rain or by some pest or disease. Depending upon the number of transplantings done in the seed beds or in the pan, the planting date is adjusted. The final transplanting is generally done when the plants develop eight to ten leaves. A fortnight before the actual planting, the flower beds should be dug up to a depth of 15″ to 18″. Ample quantities of well-sifted leaf mould and well-decomposed horse or cow dung is incorporated into the soil and all stones, pebbles and such extraneous matters removed. The clods should also be broken up so that the soil well-mixed with manure becomes a well-pulverised uniform mass. The bed is then levelled with a gentle slope from the centre to the edge. A few hours before planting the beds are watered to settle the soil evenly. When the soil becomes fairly dry, the position of each plant is marked. The spacing is adjusted according to the expanse or spread of the plants when fully grown, so that each plant has enough room to show itself at its best. About a strip of three to six inches width is generally left unplanted along the edges of the bed. The potted plants are brought near the bed and the seedlings are knocked out of them along with the soil. Each seedling is then removed with its roots and a bit of soil attached to it and is planted in a small hole made in the bed with a stick or with a finger. Seedlings are generally planted at the same level as they are in the pan or seed bed, but in some cases they can be planted deeper up to the base of the first leaf for stability. Temporary shade with some leaf branches is provided for the first few days till the seedlings get established.

Shrubs and trees, which are not planted in beds, are also treated in a similar fashion, except that each plant is spaced more or less in the way that plants, mentioned under Part I, are at the time of planting.

Immediately after planting, a good irrigation must follow, taking care to have a very fine spray irrigation in the case of small seedlings, as those of annuals planted in beds.

Chapter VI

POTTED PLANTS

Cultivation of plants differs not only from plant to plant but according to the way in which each plant is grown. For instance, the care required in maintaining a potted plant is not the same as that in a bed or in open ground. Potted plants are an essential part of a programme of the beautification of a home garden or park. Pots are of different sizes and shapes. For shallow rooted plants, like ferns and for use of seed pans, the height of the pots is naturally much lower than those used for trees with their long tap roots. For orchids, which thrive only when excellent aeration is provided for their roots, pots plentifully perforated on all sides are utilised. For bog plants, two pots are used, one placed inside the other with some space left between the two for filling up with water, sand and damp mass, in order to keep the plant in the inside pot continuously moist.

The method of filling up a pot has already been explained for seed pans. With some variation, this method is used for most of the plants. After the crocks are spread at the bottom, in addition to coarse sand, coconut fibre may be used and over this compost mixed with soil may be used for hardy plants or a mixture of soil, manure, sand, leaf mould etc. Many different mixtures have been recommended to suit the different types of plants. For instance, for Crotons, red earth, horse manure, leaf mould and sand in proportions of 4, 4, 3 and 2 respectively have been suggested, while for bulbous plants like Canna or Dahlias, red earth, sand and manure in 2, 2 and 3 respectively are recommended with a very small quantity of charcoal added to the mixture. For palms, the leaf mould is used in large quantities roughly to form 1/3 of the mixture with red earth, loam and manure, and sand forming the rest in almost equal proportions. For cuttings, the mixture suggested is roughly three parts of red earth, two of leaf

mould and two of sand. The plant is planted in the centre of the pot and the soil is pressed firmly all round after planting. Great care is necessary in watering the potted plants. If the pot is kept excessively moist, the aeration at the roots is prevented and the plant may soon wilt. If the soil is dry then the plant shows distress. A careful watch is, therefore, essential to judge when water is necessary. It is not possible to apply the same quantity of water for every plant, as requirements will vary depending upon the drainage and the utilisation of moisture. An occasional stirring of the soil by hand or with a hand-fork is useful to prevent the soil from becoming hard.

Chapter VII

CULTURE

After the planting of annuals, daily watering in the evening with a rose can is necessary except when there are rains. About once a week, the surface soil around the seedlings requires to be stirred up to promote aeration. Many seedlings also benefit by the application of liquid manure. This is given once a week from the time when the first flower buds appear and is continued throughout the flowering period. Liquid manure is usually prepared by placing about half a basket of cow or horse dung in a bag, the top of which is tied up, and dipping it in a tub of water. After about eight hours the bag is stirred. The liquid so obtained is diluted slightly to give the colour of weak tea decoction and is then used for watering the plants.

As soon as gaps are found to occur in the beds these should be filled up from the reserve plants maintained for the purpose. Such gap filling, however, is possible only in the very early stages. Staking the plants is done wherever necessary. Apart from the stirring of the soil, prompt removal of weeds is an essential daily operation.

Some disbudding is necessary so that the blooms produced from the remaining buds may be of the size required. If allowed to flower indiscriminately some plants like Chrysanthemum produce small blooms. Particularly for show purposes, large blooms are secured by constant attention to disbudding, apart from the selection of the seed from the best parental source.

Pruning is of importance not only for annuals but also for shrubs and trees, both for regulating the shape and size of the plants and also the size and the quality of blooms. Uneven or lop-sided shape of an ornamental plant reflects the lack of care in training or pruning.

In shrubs, pruning for shape is done mainly when the

plants are young. To encourage even growth and development in the plant, the misplaced branches have to be cut off and branches that come low down the stem have to be pinched off or removed. Whenever the pruning is done in shrubs or trees, the cut has to be given either to an inner or outer bud according to whether the future growth is to be directed inwards or outwards.

Pruning for flowering depends on the flowering habits of the shrubs. Those which produce flowers on old shoots have to be pruned severely by cutting back the branches just behind the flowers each time they cease flowering. For those which flower continuously, pruning for shape is done preferably during the beginning of the monsoon in most areas or towards the end of the monsoon in areas where the rainfall is very heavy. Any shrub in which flowers are produced on new wood should be pruned once a year after the flowering season is over. Thinning of the new flower bearing wood can be done to regulate the disposal of the blooms on the plants.

In the case of annuals, pruning is limited only to the removal of misshaped shoots or to thinning of the crowded areas.

Until the shrubs start to bloom, occasional and adequate irrigation, with a mulch of dry leaves, grass or straw around the roots, is all that is necessary. Liquid manure benefits the shrubs when they commence to bloom, if applied once a week.

Flower beds and annuals

Annuals are the most popular plants in a garden. They are grown to last for a season or a year. There is a class of plants called biennials, which may be grown for a season in the same way as the annuals. All annuals are most effective when massed in beds. Their large number of kinds and varieties afford ample opportunities for working out different combinations and obtaining different effects. It is possible to grow annuals practically throughout the year in beds, choosing the plants to suit the proper season. Annuals, therefore, provide a succession of delightful flowers from

which a well-thought out scheme of gardening can be implemented to suit all tastes.

Three broad groups of these flowers are recognised: (i) rainy season annuals, (ii) cold season annuals and (iii) hot weather annuals. As already explained, annuals are generally sown in seed pans and then shifted out to the beds in the open.

The following is a statement that has been compiled at the Agricultural College and Research Institute, Coimbatore, to indicate the characteristics of some of the most important annuals or ornamental plants and which may be of value to the amateur gardener.

Name of plant	Colour of Flower	Height in inches	No. of weeks taken to attain full flowering	Flowering period in weeks
(1)	(2)	(3)	(4)	(5)
Alyssum ..	Varies	6-9	15-16	8-10
Aster ..	,,	15-18	15-18	6-8
Bachelor's Button	,,	6-9	8-10	6-8
Balsam ..	,,	12-15	8-9	5-6
Calendula ..	,,	12-15	15-16	6-8
Calleopsis ..	Yellow	15-30	15-16	10-12
Celosia ..	Varies	15-18	10	6-8
Cosmos ..	,,	36-48	8-10	6-8
Dianthus ..	,,	15-18	16-18	8-10
Gerbera ..	,,	12-15	36-40	12-15
Marigold ..	,,	24-36	8-10	6-8
Nasturtium ..	,,	6-9	7-8	5-6
Petunia ..	,,	12-15	10-12	8-10
Phlox ..	,,	10-12	16-18	6-8
Portulaca ..	,,	4-6	10-12	6-8
Salvia ..	,,	24-30	15-16	8-10
Tithonia ..	Orange	60-72	8-9	6-8
Verbena ..	Varies	6-9	16-18	6-8
Vinca ..	,,	24-30	8-9	6-8
Zinnia ..	,,	24-36	10-12	5-6

Herbaceous perennials

Since there are a very large number of flowering and foliage shrubs of ornamental value, information on the value of these is useful in deciding upon the pattern of their arrangement in the garden to achieve the maximum aesthetic effect. Herbaceous perennials truly form the framework of a garden and the chief feature of the land-scape gardening, because they are permanent and showy, whether placed in front of tall trees or fringing a spacious lawn, or spreading their charm along the boundaries as background to the more concentrated mass of colour from the annuals. Their value in a garden when the colour of the annuals has faded, cannot

Class of shrubs on the basis of their stature	Normal height of shrubs with			
	pink as charming colour	red as charming colour	orange as charming colour	yellow as charming colour
Low under 18″	Begonia, Crossandra, Zephyr lily	Begonia, Eranthemum, Euphorbia	Crossandra	Asystasia Crossandra, Lantana depressa
Medium 18-36″	Poinsettia	Poinsettia, Plumbago rosea	Clerodendron	Galphimia
Fairly tall 3-4 ft	Barleria, Hibiscus, Tecoma rosea	Achania, Hibiscus, Russelia floribunda, R. juncea	Hibiscus	Hibiscus
Tall 4-6 ft	Ixora rosea, Jatropha, Lagerstroemia	Acalypha, Hibiscus, Ixora, Jatropha, Lantana	Cestrum, Hamelia, Ixora, Tecoma capensis	Allamanda, Bauhinia, Lantana, Lawsonia, Tecoma smithii
Very tall 6-8 ft	Bauhinia rosea, Dombeya, Oleander	Oleander	Caesalpinia	Caesalpinia, Oleander, Tecoma stans, Tithonia

Class of shrubs on the basis of their stature	Normal height of shrubs with			
	blue as charming colour	purple as charming colour	mauve as charming colour	white as charming colour
Low under 18″	Commelina	Eranthemum	Lantana	Bauhinia, Begonia, Malphigia tuberosa
Medium 18-36″	Dedalacanthus, Salvia	Angelonia	Pentas	Clerodendron, Plumbago
Fairly tall 3-4 ft	Clerodendron, Plumbago		Hibiscus	Clerodendron, Gardenia, Hibiscus, Parax, Tabernaemontana
Tall 4-6 ft	Duranta, Meyenia	Barleria, Cestrum, Meyenia, Petrea	Lagerstroemia	Barleria, Brunsfelsia, Cestrum, Duranta, Ixora, Lagerstroemia, Meyenia, Myrtle
Very Tall 6-8 ft		Allamanda		Dombeya, Murraya exotica, Oleander

be over estimated. They also screen from the view such disagreeable features as a cow shed or a manure pit. Some of the shrubs can be grown in large pots or tubs. The above statement compiled at the Agricultural College and Research Institute, Coimbatore, indicates the colour of the more important herbaceous perennials along with their size. The information furnished in the statement may help the reader to some extent in planning a mixed herbaceous border or in adjusting the colour scheme in the garden as a whole.

Bougainvilleas :—This plant is said to have been named after a French navigator. It is well-known as the most attractive floriferous plant with resplendent colours and colour shades of red, orange, purple, pink, mauve and even white. It is hardy enough to be grown on any soil and requires the minimum of attention. Being a rapid grower, it may be used even as a hedge or fence plant, to cover trellises or porches or as a climber over walls or trees. It is also used often as a shrub. Sections of gardens devoted to a collection of bougainvilleas are designated as "Bougainvillaeries". To secure good flowering the adult plant should be watered very sparingly about three months before the date when the blooms are desired. The object should be to starve the plants so that the leaves may drop off. When watered again liberally, new shoots are put forth with a mass of colour. Though new varieties are produced by seed, bougainvilleas are commonly propagated by cuttings and layers. Their flowering habits vary from the flowering on old wood in some varieties to the flowering on new wood in the others. Pruning is generally done during the commencement of the rainy season. In the varieties which flower on new wood, two types of growth are distinguished, one with greyish or brown with grey streaks on fairly hard wood, which produces copious flowering and the second with brown or brownish green wood of a slightly softer nature and designated as water shoots because of their faster growth and poor flowering capacity. This latter class of wood should be removed. After flowering ceases, the flowering shoots are cut off just behind the parts where flowers appear. Water is also reduced for a few weeks and manure is applied. With the renewal of watering soon after manuring, a fresh crop of flowers appears on the plants. The manure applied usually consists of a basket of well-decayed horse dung, half a basket of leaf mould with about a handful of bone meal or superphosphate. Among the bougainvilleas which are suggested for pot are Pink Beauty, Rosa Multiflora, Refulgence, Scarlet Queen and Mrs. Louis Wathen. The following list compiled at the Agricultural College and Research Institute, Coimbatore, gives the uses and colour of some of the well-known varieties.

Variety	Colour	Uses
Scarlet Queen	Deep crimson, tinged with mauve	Climber, pot plant, and shrub
Mrs Louis Wathen	Orange fading to pink	Pot, shrub
Purple King	Purple	Shrub
Refulgence	Purple white centre	Climber, shrub and pot
Princess Margaret Rose	Pink mauve	Shrub, climber
Maharaja of Mysore	Rose pink	-do-
Mrs Buck	Bright pink	Shrub

Hibiscus. :—Though classed as a herbaceous perennial this group of plants is very popular in Indian gardens and is largely used in mixed borders, shrubberies or as individual plants along a drive. They are all propagated by hard wood cuttings. The flowers spring up from old wood on short stems. Generally two kinds are recognised—one producing single flower and the other double flowers, the colour of flowers being pink, red, white, blue, mauve, deep orange and mutabilis (white, changing through pink to purple in 36 hours). Most of these grow five to six feet high in a couple of years reaching ultimately even up to eight feet. Generally they are required to be replaced after four or five years.

Climbers and Creepers :—Climbers which are treated as annuals are generally raised by seed, while most others are raised by hard wood cuttings. To raise these plants on trellis, it is usual to dig a trench roughly two feet wide and two to three feet deep and prepare the soil inside as if for a flower bed. The plants are planted in the trench and they are then trained horizontally along the trellis before they are allowed to climb. Annual creepers are not given any pruning. For perennial creepers, however, frequent light pruning is

needed for shape, with annual pruning to secure blooms in profusion. Plants which flower on new wood require to be cut down to about six inches to one foot from the ground level every year, generally at the commencement of the monsoon, while those which flower on old wood are pruned for shape, removing some of the oldest and least vigorous growths. A list of the more important climbers and creepers that has been compiled at the Agricultural College, Coimbatore, is given below to indicate the flowering season with colour of flowers and other particulars.

Name	Colour	Flowering season	Flowering on old or new wood	Replacement period	Propagation
Antigonon	Pink	Always	New	6 months —2 years	Seed T
	Orange	Jan-March	Old	No	
Bignonia	Yellow	Always	,,		H
Honeysuckle	White	March-July	,,	No	
Ipomoea sp.	Purple	Always	New	1 year	Seed, T
Jacquemantia	Blue	,,	,,	No	,,
Jasmine	White	,,	,,	No	H
Passion flower	Purple	July-Oct.	,,	No	H
Petrea volubilis	,,	Always	Old	No	H
Quisqualis (Rangoon creeper)	Red	,,	New	No	Suckers
Thunbergia	Blue and White	,,	,,	No	H
Hiptage madablota	White	Jan-March	,,	No	Seeds and Layering

H = Hard wood cutting T = Terminal shoots or cutting

Bulbous plants :—These plants pass through three stages in their growth—resting period, growing period and blooming period. Bulbous plants are prized for their foliage and flowers and look pretty when massed in beds as is commonly done with Cannas, or planted in borders as in the case of Dahlias or in hanging baskets as with Achiemenes or for cut flowers as in the case of Gladiolus, Iris etc. Most of the bulbous plants thrive in the hills but in the plains only Amaryllis, Canna, Caladium, Alocasia and a few others put up a reasonably good show. After the resting period, the bulbous plants are taken out and placed in moist sand and when new shoots grow up to about an inch, they are potted or planted out. Sandy loam, rich in leaf mould, is preferred but fresh manure is considered undesirable for these plants especially when in contact with the bulbs. The plants are sometimes staked and liquid manure is applied once a week. Artificial fertilisers are avoided as they are believed to scorch the tender foliage. When growth ceases, the leaves turn yellow and the plant begins to die. At this stage, water supply should be stopped. The bulbs are then removed and stored in a cool shady place for a few days till the excess moisture is lost. Then they are put in dry sand in a cool place, each bulb not touching the other.

Cannas :—Cannas form one of the most popular bulbs as bedding plants but they need very rich soil and very open situations. Leaf mould, compost and other types of organic manure are used liberally to fill up the beds from four to six inches depth. Each shoot of a plant produces usually two flower heads and the flowers which die first are removed promptly and when both the flower heads have passed their period of usefulness the plant may be cut down. Application of liquid manure during the blooming period is found useful. Cannas also require good soaking irrigation during their growth. When the blooming is over, each Canna rhizome may be dug out and may be sliced into sections each containing three or four buds. These may then be placed in pots in old soil with some sand around the rhizome. The pots should be kept in shade and watered twice a week, till they are

planted in about August to October. Among the varieties Taj Mahal is known for its cream coloured bloom, Master Piece and Star of India for their yellow bloom, Herbert Hoover for its pink bloom, President for its red bloom and Mrs. Woodrow Wilson for its orange bloom.

Chrysanthemum :—This is grown on a commercial market garden scale in Tudiyalur near Coimbatore (Madras). The plants are planted in April-May and up to August-September in beds prepared after four to six ploughings and addition of about 50 cartloads of farm yard manure with some groundnut cake or poudrette. The propagation is done through slips taken from the previous crop. Plants are given a spacing of six to eight inches between the row and within the row. Irrigation is given once a week and about six weedings are done during the crop's life time. About six months after planting, top dressing with ammonium sulphate at the rate of three bags per acre is recommended. The first picking begins from about the seventh month, after which it may proceed twice a week and the peak season is two months later. Two varieties of Chrysanthemum are grown for the market, one being white and the other yellow. Chrysanthemum for gardens is not however popular in South India.

Edges :—For dividing beds, to provide borders for the roads, walks or paths, live edging with dwarf plants is very popular. Such plant edging is done normally by planting Alternanthera, Eupatorium, Pilea, Santolina, Cineraria maritima etc.

Rockery :—With *Agaves, Alocasia, Anthurium, Begonia, Cactus, Caladium, Dracaena,* ferns of different types, *Lantana, Portulaca, Tradescantia, Verbena, Sanseviera* and a large number of other plants rockeries can be raised. Such artificial rockeries provide not only a place to grow the plants under congenial conditions but also to produce a charming effect.

Conservatory :—This is a structure inside which are displayed plants which cannot stand exposure to sun for a long time. Ferns, Orchids and palms are plants which love shady and humid atmosphere. Maranta, Rex Begonias,

Cinerarias are some other plants which are also used to beautify the conservatories.

Roses:—Roses are grown both in market gardens as well as in ornamental gardens. Unfortunately good roses are scarce in South India, except around Coonoor in the Nilgiris. In many places in the plains, rose culture has suffered as these plants are very sensitive to brackish water, which is the only one available for irrigation purposes. There are several distinct classes of roses recognised on the basis of their growth, habit, size, shape, colour, fragrance etc. Among the rose varieties, Common Edward which is a very hardy, vigorous, profuse and frequent flowering type, propagated largely by layering, is the one usually found in the State of Madras. In the hills, the Hybrid Tea group of roses is most popular, producing massive and gorgeous coloured roses suitable for house decoration or the button-hole. These are represented by such varieties as General MacArthur, Betty Uprichard and Dean Hole. The common climbing rose variety, Marshall Niel, belongs to a different group. At Coonoor, budding is now being adopted for raising choice varieties on the wild briar stock. Roses require well-drained rich loamy soils. They are planted in pits 15 inches cube dug 2½ to 3 feet apart and are manured with plenty of farm yard manure, leaf mould and sand and sometimes with a supplement of bone-meal and sulphate of potash. Roses need annual pruning, especially the Hybrid Tea Rose which requires special attention in this respect. The pruning consists of the removal of all canes except three or four, which are cut back to about two buds from the base. This is done in February in the Nilgiris and during October-November in the plains.

Jasmine:—This is perhaps the most popular flower in the Indian home and is cultivated both in home compounds as well as in market gardens. A very large number of species and varieties are being grown, of which the Jaji type (*J. grandiflorum*) and the Malligai type (*J. sambac*) are the most important. The jasmine loves a loamy or sandy soil with liberal applications of manure, while in clay soils rank vegetative growth is fostered. In all 30 to 40 cartloads of

farm yard manure are applied to the land before planting and three to four ploughings are given. Spacing is usually three to four feet in some places. Malligai type is propagated by cuttings while the others by layers. The cuttings are usually three to four feet in length and are rolled into coils and planted with their ends also buried in the soil. In some places, the jasmine is trained on *pandals* while at Poonamalle (Madras) no propping is given. Flowering commences from the second year though economic yields of flowers are obtained only from the third year. Watering is usually stopped in December and leaves are made to shed. Dried shoots are lightly pruned and roots are exposed by digging in January. Manuring of the plants follows with cattle manure or compost, while in South Kanara burnt earth, goat and pig manure are also used. Watering of the plants is resumed from February. The flowering commences from March and continues up to November depending upon varieties and species. Jasmines produce flowers for as long as 50 years.

Lawns:—The lawn provides a refreshing site to the eye and helps to bring out the beauty of flower beds with greater effect. To prepare a lawn, the soil has to be dug to about two feet depth. All stones and roots of other vegetation including nut grass should be removed. Farm yard manure or sifted municipal rubbish may then be incorporated in ample quantities to provide a rich medium for the grass to grow. The best grass for lawns is Hariali being low growing, hardy and responding to frequent mowings. About 25 lb of seed is considered enough for an acre but it has been found more satisfactory in India to raise a lawn by turfing. For this, turf (pieces of earth with thick growth of Hariali on them) may be secured and all weeds removed. The turf may then be spread on the ground to produce a uniform turf growth and then they may all be beaten down flat by ramming. Watering and rolling may then follow. It is possible to raise a lawn by chopping the Hariali grass into bits of about four inches and mixing it with fresh cow dung in water and sprinkling the mixture on the ground fairly thick at the rate of about 100 lb

of grass to cover over 400 sq ft of the ground. It is also possible to collect small roots of Hariali and dibble them about six inches apart into the prepared ground soon after it has rained. This is considered to be the cheapest method though it is slow. However, a lawn needs a thorough weeding at least once a month during the first two or three months and at more frequent intervals thereafter. A lawn mower should be worked regularly at fortnightly intervals. An ordinary scythe can be used when the grass is very long. Rolling the lawn with a roller once in three months, preferably after it has rained, is also a desirable operation. During summer months, weekly irrigation to the lawn is desirable. It is usual to renew the lawn every three or four years.

Hedges:—To screen off unsightly corners or objects and to demarcate or define or protect a garden and also to act as a border and ornament, hedges are very useful. For tall hedges i. e. (those about six feet high) *Clerodendron inerme, Dodonaea, Tecoma stans* and *Thevetia* are commonly employed. For medium hedges (i. e. those about four feet high) Hibiscus white and yellow, Lantanas and Thevetia are used. For low hedges, Casuarina, Hibiscus and Lantana are employed. A trench is dug generally about two feet wide and two feet deep and the soil is replaced alternating with layers of manure or leaf mould which are all mixed up later. The seed is sown or the seedlings are transplanted in this. Watering is done on alternate days for the first six months and later at longer intervals. It is good to give a mulch to the plants. The hedge has to be trimmed regularly if it is to be an object of beauty.

Chapter VIII

PESTS AND DISEASES

A. Pests

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
ROSE			
Grape thrips	These minute insects appear in large numbers on tender leaves and shoots and suck the sap causing a blighted appearance to the affected parts	Spray BHC (1 oz per 3 gallons). Tobacco decoction also effective	The characteristic red coloured nymphs (young ones) carrying droplets of fluid at the abdomina tips are easily identified. Often very serious
Red scale	Colonies are found adhering to twigs and leaves, sucking the juice	Spray Folidol (1 oz in 12½ gallons of water)	Sometimes whole plants are killed by this scale. It is a well-known pest of oranges elsewhere but not noted on oranges as yet in South India
Aphids	Colonies of these plant lice found on the tender shoots and leaves, feeding on the sap	Spray HETP (1 oz per 6¼ gallons)	Often a serious pest

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
Leaf caterpillars	Defoliate the plants	Dust BHC	There are two or three species of caterpillars feeding on rose plants
Chafer beetles	Adult beetles feed on flowers and foliage	Dust BHC on foliage; apply also to the soil to kill grubs	
Leaf cutter bees	These cut the leaves neatly and take the cut bits away for building nests	Dust BHC	Only a minor pest
JASMINE			
Red scale	See under Rose	See under Rose	See under Rose
Mealy bugs	Colonies adhere to tender parts and suck sap	Spray Folidol (1 oz. per 12½ gallons)	A beautiful delicately built white insect found sometimes in numbers on the foliage
Jasmine bug	Feed on the juice from flowers and buds and cause wilting and shedding of flowers	Dust BHC	
CHRYSANTHEMUM			
Caterpillar	Feeds on foliage and flowers and causes severe damage sometimes	Dust BHC	Insect is found also on pulses in different parts of India

Insect	Nature of injury done to plant	Suggestions for control, if any	Remarks
OLEANDER			
The Oleander sphinx	The stout big caterpillar defoliates the plants	Dust BHC 5%	The caterpillar is a very stout and long one with a spine over the tail end
The Oleander butterfly	The caterpillar defoliates the plants	-do-	This is a common pest of Oleander
GARDEN CROTONS			
Scales and mealy bugs	Cover shoots and stems and suck sap, often killing the plants completely	Spray Folidol (1 oz in 12½ gallons)	
Thrips	Found in numbers on shoots and stems, feeding on the plant sap	Dust or spray BHC	

B. Diseases

Crop	Disease	Control measures
HOLLY HOCK	Rust	Removal of heavily infected leaves and plants. Spraying with Copper fungicides as a prophylactic measure. Dusting finely powdered sulphur or spraying lime sulphur may also be done
SNAP DRAGON WILT		Sterilization of the soil in the flower bed by burning trash and dried leaves. Drenching the soil at fortnightly intervals with Cheshunt compound

Crop	Disease	Control measures
Azalea	Leaf gall	Removal of deformed leaves and shoots and spraying with Copper fungicides like Cupravit
Bougainvillea	Leaf blight	Spraying the foliage with 1% Bordeaux mixture, Cupravit or other Copper fungicides just at the commencement of the rains
Chrysanthemum	Powdery mildew	Dusting the foliage with finely powdered sulphur or spraying with lime sulphur
	Rust	Dusting with finely powdered sulphur or spraying with lime sulphur
Dahlia	Smut	Removal and burning of the diseased leaves and tops and avoidance of raising the crop in the soil which has grown a diseased crop for a couple of years
Carnation	Ring spot	Selection of cuttings from healthy plants and spraying the leaves with Copper fungicides. The spray should not fall on the flowers
	Leaf spot	Removal of diseased leaves and protecting the foliage with Cupravit or other Copper fungicides
Sunflower	Rust	Dusting finely powdered sulphur or spraying with lime sulphur
Shoeflower	Flower rot	Protection of flower during rainy period. The infection is generally confined to the flowers only and does not normally extend to the leaves and shoots

Crop	Disease	Control measures
SHOEFLOWER	Virus disease	Eradication of affected plants and selection of cuttings for propagation from healthy bushes
JASMINE	Rust	Pruning of badly affected parts and dusting finely powdered sulphur or spraying lime sulphur
	Leaf spot	Spraying the plants with 1% Bordeaux mixture or other Copper fungicides. More than one spraying may be necessary depending on the intensity of the disease
SWEET PEAS	Powdery mildew	Dusting the plants with finely powdered sulphur or spraying lime sulphur
POPPY	Leaf smut	Removal of infected leaves from the early stages and spraying the foliage with Cupravit or other Copper fungicides
GERANIUM	Black leg (Foot rot)	Sterilizing the soil in the seed bed and drenching the soil with Cheshunt compound at fortnightly intervals. In case the upper portions of the stem are affected, spraying 1% Bordeaux mixture or Dithane 2·78 (1 lb. in 66 gallons of water)
PETUNIA	Damping off	Sterilization of the seed bed soil and drenching the soil either with Cheshunt compound or 1% Bordeaux mixture at fortnightly intervals
	Virus disease	Roguing of virus affected plants and avoidance of collection of seed from diseased plants

Crop	Disease	Control measures
PHLOX	Leaf spot	Spraying the foliage before flowering with Copper fungicides. Some varieties are more susceptible than others
ROSE	Powdery mildew	Dusting the foliage with finely powdered sulphur or spraying with wettable sulphur. The treatment should be commenced from the time of unfolding of the leaves and repeated at intervals
	Black spot	Protective spraying of the foliage with fungicides like Dithane Z·78, Cupravit or other Copper fungicides. Repeated sprayings may be necessary. The fallen leaves should be carefully collected and destroyed
	Rust	Generally not prevalent in cultivated roses. But dusting finely powdered sulphur may be done when the disease is seen
ZINNIA	Wilt or Root rot	Drenching the soil with 0·1% wet Ceresan. The solution can be used even in planted beds
	Blight or leaf spot	Spraying the plants with 1% Bordeaux mixture or Dithane Z·78
VINCA ROSEA	Blight	Spraying the plants with 1% Bordeaux mixture
	Virus disease	Roguing of affected plants from the early stages of the appearance of the disease

PART IV

TREE PLANTING

Chapter I

INTRODUCTION

The importance of tree planting is well recognised in all parts of the world. It is of special importance in a tropical country like India, where shade for men and animals during the long summer months is a necessity. To the farmer, the trees are a valuable source of green leaf to manure his lands. Providing a natural and effective wind-break, the trees are of use in preventing the loss of flowers, fruits and sometimes even of the whole crop in orchards. They also check the damage from wind blown sand. For delicate crops, like bananas and sugarcane, and also for preserving the beauty of a garden, effective wind barriers provided by solid trees are of great significance. Trees are also extensively employed to provide the necessary shade to crops such as tea and coffee. As a source of fuel and timber, the value of tree planting is appreciated by every human being, who has to depend upon these for his household needs. Some of the trees also yield fodder for the cattle, while others add to the beauty of the home and countryside either in the form of avenues or in embellishing the landscape in other ways. It is true that all trees are not equally suitable for all types of requirements. This is the reason why we have to regulate tree planting to suit every purpose and also every tract. The economic value of tree planting, whether in orchards or through a careful selection of trees for avenues and other purposes to yield valuable products, cannot be overestimated.

Many leaders of thought have emphasised the fact that "great opportunities exist in the villages of India for planting fruit, timber and fuel trees". The realisation of this has led to a nationwide drive for tree planting, as distinct from the improvement and extension of forest planting, which too has attracted a good deal of attention recently.

Chapter II

PROPAGATION AND RAISING OF SEEDLINGS

Trees, other than those used for commercial orcharding, are raised commonly either by seeds or by cuttings. Some of these trees can of course be raised by both the methods. The seeds are sown in well-prepared beds, which need not be raised except when the seeds are very tiny like those of vegetables or flowers. Flat beds are, therefore, common and these may be prepared in sizes of roughly 10 feet ×5 feet. After the beds are prepared, the soil inside the bed may be dug out and about two to three baskets of well-rotted cattle manure may be incorporated well into the soil. The seeds may then be sown in the bed after levelling the soil and removing all stones or other extraneous matter. The spacing depends upon the species or the variety of tree and also the size of the seed. Usually 3″ to 6″ from seed to seed in the row and 6″ to 12″ between the rows is considered adequate. The beds should be regularly watered till the seedlings are 9″ to 12″ high. At this stage, the seedlings may be shifted from the beds to pots or baskets to make them portable. The plants are retained in these containers for about six months prior to planting in their permanent sites. Most of the seedlings attain a height of about two feet by this time.

When the trees are raised by cuttings, the beds may be prepared in the same way as for seedlings and cuttings 12″ to 18″ long from well-ripened wood of the past season's growth may be planted with a spacing of about six inches in the rows and 12″ to 15″ between the rows. Sometimes cuttings are planted directly in the final site at the rate of three or four per pit but this is not always satisfactory and the maintenance cost of such cuttings dispersed over a wide area becomes heavy. The rooted cuttings are shifted after they have grown to a height of about 9″ to 12″.

Chapter III

PLANTING AND TREE GUARDS

The planting of the rooted cuttings, as well as the seedlings, is done usually in South India during the monsoon months i.e., June to December. Where the rainfall is very heavy as on the West Coast, it is, however, usually deferred towards the end of the South West monsoon in about August-September. The seedlings are removed from the pots or baskets with care so as not to disturb the roots and then placed in the pits filled with good soil and watered immediately. Generally, pits two feet cube are dug for the trees in advance and these are filled with good soil before the plant is put into the pit. The rooted cuttings are also planted in the same way with their roots enclosed in a ball of earth.

The general opinion is that seedlings being deeper rooted will be able to establish and thrive better than the shallow rooted plants raised through cuttings.

The regular watering of the plants has to be done for at least a month after the planting unless the rainfall is adequate.

Tree guards: One of the chief dangers to newly planted trees is the destruction caused by men, cattle and goats. Providing strong protection to the plants is, therefore, very important. Tree guards of several kinds are being used for this purpose. Thorny, dried twigs can be got together and planted around the plants immediately after planting. In urban areas, iron or cement concrete guards are commonly used and sometimes old tar drums are employed for this purpose after removing the basal piece as well as the lid and after providing some holes all around to admit air.

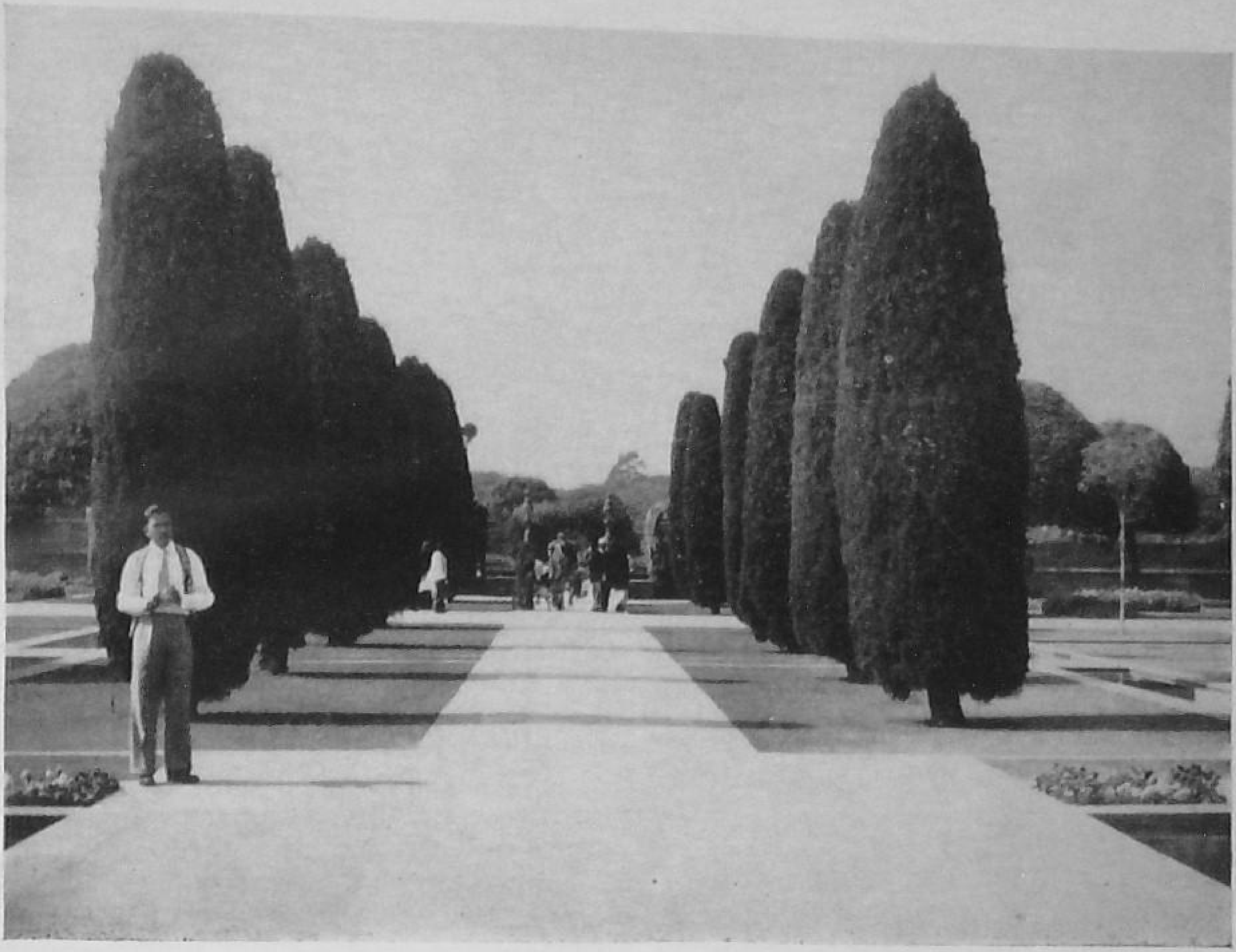
Trees have their characteristic shapes and these have to be maintained or fostered by corrective or regulated pruning. In the case of avenue trees, however, pruning has to be directed towards the removal of all lower branches in order to ensure that the trees grow erect and branch high up.

Chapter IV

IMPORTANT TREES

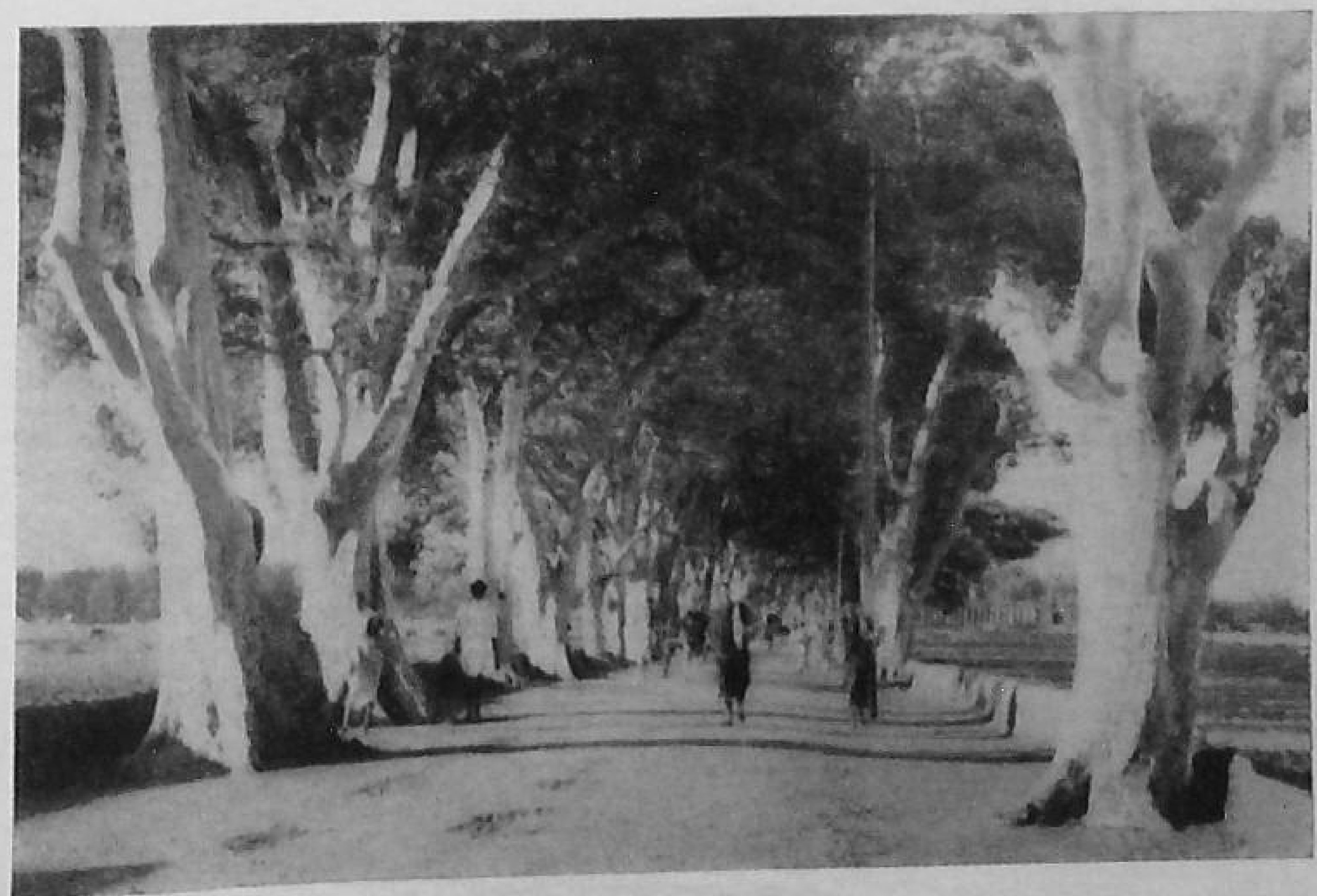
(i) For avenues :—A list of the common trees which can be employed for planting on either side of roads is given below. This list has been compiled by the Madras Agricultural Department and is presented here with only slight modifications.

1. *Albizzia lebbeck* Benth. (Women's tongue). : A large sized pretty tree with plenty of foliage. The plant is easily propagated by seed and gives excellent timber.
2. *Azadirachta indica* A. Juss (Neem) : An economically important tree which remains evergreen and stands drought well. Easily propagated by means of seed, it is useful as a source of fuel.
3. *Cassia siamea* Lamk. : A very quick growing tree suited to dry areas. Easily multiplied by means of seed.
4. *Delonix regia* Raf. (Flamboyant) : One of the commonest rapid growing trees, very striking when in flower. Suited to moist as well as dry localities. Propagated by seed.
5. *Enterolobium saman* Prain. (Rain tree) : A very quick growing large sized tree, which comes up well in almost all localities. The pods contain a little sweet pulp which is relished by cattle. Useful as fuel also. Propagated by seed.
6. *Ficus religiosa* L. (Peepul) : A well-known avenue tree with spreading branches which stand supported on 'pillar roots'.
7. *Ficus tsiela* Roxb. (Yellow barked fig) : A large spreading tree without aerial roots. Handsome tree with smooth bark. Bark gives a good fibre, propagated by seed or cuttings. Suited for dry areas and coastal tracts.



Stately columns like these lend dignity to approach roads

Avenue of Terminalia arjuna



Avenue of Syzygium jambolanum

A light tree guard

8. *Hibiscus tiliaceous* L. (Cork-wood bendy): Suited for sandy coastal tracts. Easily propagated by means of cuttings. Suitable as a source of green manure.
9. *Jacaranda mimosaefolia* D. Din, *J. ovalifolia* R. Br.: A graceful tree growing to 30 feet to 40 feet having beautiful blue flowers which appear at different seasons. Easily raised by seed.
10. *Kigelia pinnata* Dc. (Sausage tree) : A tall tree with suspended fruits. Easily propagated by seed.
11. *Lagerstroemia flos-reginae* Retz. (Queen's flower, Pride of India) : An attractive tree bearing prolific rosy flowers from April to July. Raised by seed.
12. *Peltophorum ferrugineum* Benth.: A pretty tree which is growing in popularity. Blossoms with rain. Suited to most localities in plains and easily propagated by seed. It is a source of timber and fuel.
13. *Pongamia glabra* Vent. (Indian beech): A slow growing tree the leaves of which are used as green manure, while wood makes good timber. Raised by seed. Suited to delta tracts, bunds, rivers and canal banks.
14. *Polyalthia longifolia* B. & H. (Indian Mast tree, Asoka): A symmetrical tree ideal for avenue. Adapted for all kinds of soils.
15. *Spathodea campanulata* Beauv. (Fountain tree): A conspicuous tree which thrives well up to 4,000 feet. Common in plantations.
16. *Syzigium jambolanum* Dc. (Black plum): An economically important medium sized tree which forms a good avenue tree. Bears purple coloured fruit. Propagated by seed.
17. *Tamarindus indica* L. (Tamarind) : A common tree suited well for avenues, readily propagated by seed. Gives the tamarind of commerce. Wood is used as fuel.

18. *Terminalia arjuna* W.A. (White Murdah) : A large sized tree commonly grown on roadsides. Propagated by seed.
19. *Thespesia populnea* Cav. (Tulip tree) : An evergreen, quick growing tree suitable for avenues which comes up well near the coast. Propagated by cuttings. Wood is used as fuel.

(ii) FOR ORNAMENTAL PURPOSES :—There is a very large list of trees which may be selected purely for ornamental purposes. Some of these are reputed for their showy flowers, while others are prized for their ornamental foliage or other features. The following list gives the names of a few which are valuable in respect of these attributes.

(a) Flowering trees :

1. *Bombax malabaricum* DC. (Silk cotton tree) : A tall tree with branches suggesting the shape of a candalabra, producing in January-February flowers which are flushy with bright red colour.
2. *Calophyllum inophyllum* L. (Dilo oil tree) : Bears handsome foliage of dark green lustrous leaves and fragrant white flowers in May-June followed by round fruits borne in profusion in clusters.
3. *Cassia javanica* Linn, and *Cassia renigera* Wall. These and several other species of *Cassia* produce flowers in a wonderful array of colours, generally during the summer months, which are a veritable feast for the eye.
4. *Erythrina indica* Lam. (Indian coral tree) : Produces scarlet red flowers in March-May. This tree can stand considerable pruning. There are other species of this also like *E. lithosperma* which have ornamental flowers.
5. *Gliricidia maculata* H. B. & K. : During the summer months, it produces a profusion of light purplish pink flowers all along the branches, presenting a striking appearance. It is also quick growing and a valuable source of green manure.

6. *Magnolia grandiflora* (Champa): This tree with pretty foliage produces sweet scented flowers in summer.
7. *Michelia champaka* Linn. (Shambaga): It bears scented flowers in summer which are popular for offerings in temples. The colour of the flowers varies from white, light yellow to red.
8. *Millingtonia hortensis* Linn. (Indian cork tree): A tall tree but rather brittle, producing bright green leaves and pure white flowers which are fragrant and profuse. Flowers twice a year in about June and November.
9. *Plumeria*: Several species of this tree produce fragrant flowers in profusion.

(b) Foliage trees

1. *Araucaria :* These are beautiful tall trees excellent in lawns and for large pots or tubs. Several species of this are grown.
2. *Casuarina equisetifolia* Forst. : A lofty tree quite ornamental and useful for fuel.
3. *Cupressus :* There are several species, which are either evergreen trees or shrubs, and all are noted for their beauty and grace.
4. *Eucalyptus* L. Her. : This too comprises many species which produce leaves from some of which essential oils, including Eucalyptus oil, are prepared.
5. *Grevillea robusta* A. Cunn. (Silver oak): A tall handsome tree, particularly when young, with ever green foliage. It is almost fern-like in appearance.
6. *Polyalthia longifolia* Hk. F. & T. (Ashok) : An erect growing elegant tree with lance shaped shining leaves and wavy branches.

(iii) FODDER TREES: The following is a list of trees compiled by the Madras Agricultural Department and raised mostly by seed, except when mentioned otherwise, to serve among others as sources of fodder for cattle.

1. *Acacia arabica* Willd. : A tree well adapted for dry

climate and heavy soils. The pods are eaten by sheep and goats; the leaves and tender shoots are also eaten. The tree is valued for fuel and the bark is also used in tanning.

2. *Aegle marmelos* Corr. : This also comes up under dry conditions and can be easily raised in waste places. The fruits are valued medicinally. The young shoots and leaves are eaten by sheep, goats and cattle.
3. *Albizzia lebbeck* Benth. : Comes up well under dry conditions with a little care. The leaves form a good fodder for cattle, sheep and goats.
4. *Artocarpus heterophyllus* Linn. : Best suited for the West Coast districts. A large evergreen tree. Wood useful for many purposes; ripe fruits and young fruits are useful as dessert and vegetable respectively. The leaves are much relished by animals.
5. *Bauhinia purpurea* Linn. : With a little care and watering, comes up well and can be planted as an ornamental avenue tree also. The leaves are eaten by cattle, sheep and goats.
6. *Bauhinia variegata* Linn. : Comes up well under dry conditions and is grown as an ornamental tree. The young leaves and flower buds can be used as vegetables. The leaves are much relished by cattle, sheep and goats.
7. *Bassia latifolia* Roxb. : A large handsome tree which comes up well under all conditions except where there are extremes of climate. The seeds yield a valuable oil for burning; the flowers which contain much sugar are used as food and also for the distillation of spirit. The leaves, flowers and fruits are eaten by cattle, sheep and goats.
8. *Butea frondosa* Koen. : Comes up well in heavy and black cotton soils. The leaflets are large and are used as plates for taking food; also provides fodder for cattle, sheep and goats.

9. *Cassia fistula* Linn.: Can be grown in all places in the plains. Wood is hard and durable; the trees may be planted along avenues. Cattle, sheep and goats relish the leaves.
10. *Cassia siamea* Lamk.: A very quick tree coming up well in all places in the plains; suited for dry localities. Trees may be used as fuel. The leaves are fed to animals.
11. *Enterolobium saman* Prain.: Another quick growing tree, producing plenty of foliage. Thrives well in places of moderate rainfall. Leaves form good fodder.
12. *Erythrina indica* Lam.: Suited for all conditions in the plains. The leaves are very valuable for milch cattle. Can be propagated by cuttings also.
13. *Feronia elephantum* Corr.: A very large tree coming up well in dry localities. The pulp of the fruit is eaten. The leaves are eaten by sheep and goats.
14. *Ficus bengalensis* Linn.: A very large tree which can be grown along roadsides under all conditions in the plains. The leaves are much relished by goats and also by sheep and cattle. Can be easily raised from cuttings.
15. *Ficus glomerata* Roxb.
16. *Ficus retusa* Linn.: The above two species of *Ficus* can be grown in all districts in the plains, preferably as avenue or shade trees. They are easily raised by cuttings also. The leaves and the very young shoots are eaten by cattle, sheep and goats.
17. *Ficus religiosa* Linn.: A very large tree, often treated as sacred and can be grown under all climatic conditions except in the hills. Can be grown near village *chavadis*, temples and road sides. The leaves are valuable fodder. Can be raised by cuttings also.
18. *Pithecolobium dulce* Benth.: Suited for dry conditions and can be grown along hedges. Quick growing. The aril on the seeds are edible. The pods are

eaten by cattle, the tender shoots and leaves by goats.

19. *Prosopis juliflora* DC. : This is a tree introduced from America where the pods are valued as cattle feed and said to be 'as nutritious as corn'. It is quick growing and highly drought resistant. The leaves, young shoots and pods are useful for cattle.
20. *Sesbania grandiflora* Pers. : Requires copious watering and can be grown in the backyards, along field bunds and irrigation channels. The leaves are useful as a vegetable. The young shoots and leaves are greatly relished by cattle. A very quick growing tree, it can be used as fuel also.
21. *Zizyphus jujuba* Lam. : Suited for all dry localities. A low thorny tree, the fruits of which are edible. The leaves are relished by sheep and goats.

(iv) For Fuel : Although fuel can be obtained from every tree, commercial production of fuel through tree planting is limited to only some trees, such as Casuarina. However, fuel is also obtained from a large number of trees such as *Peltophorum ferrugineum*, tamarind, *Acacias*, *Albizzia* species, *Grevillea robusta*, *Michelia champaca*, *Eucalyptus* species, etc.

(v) For Timber : For timber also many species are useful such as the Teak (*Tectona grandis*), Sandalwood (*Santalum album*), Rosewood (*Dalbergia latifolia* Roxb.), Mahogany (*Swietenia mahagoni*), Jack wood (*Artocarpus heterophyllus*) etc.

Chapter V

PESTS AND DISEASES

A. Pests

Insects	Nature of injury done to plants	Suggestions for control, if any	Remarks
TAMARIND			
Scale insects and Mealy bugs	Colonies over fruits and leaves and suck up sap; fruits suffer badly	Spray Folidol (1 oz. per 12½ gallons), if infestation is severe	
Crab caterpillar	Feeding on shoots and leaves	Dust BHC 5%	Occasionally bad. A curiously looking greyish brown caterpillar
Bag worms	Feeding on shoots and leaves	Dust BHC 5%	Sometimes sporadic
WOOD APPLE			
Slug caterpillar	Feeding on leaves	Dust BHC 5%	Occasionally serious
EUGENIA			
Fruit fly	Maggots burrow into fruit pulp and cause fruit rot	DDT spray may be applied as a deterrent	Sometimes bad
Leaf caterpillar	Defoliates the plants	Dust BHC 5%	This is a stout green caterpillar with a characteristic swollen thorax
BABUL			
Babul scales	Colonies cover tender shoots and stem and suck sap	Spray Folidol, if severe	

Insect	Nature of injury done to plants	Suggestions for control, if any	Remarks
Hairy caterpillars	Feeding on the foliage and bark	Spray Fish oil resin soap	Appears as a very serious pest in certain years and completely defoliates babul trees in many places
PUNGAM			
Plant bugs	Swarms of the bug settle on tender shoots and suck sap	Dust BHC 5%	Sometimes whole trees are covered by millions of these bugs
PORTIA			
Black scale	Cover the tender shoots and leaves and suck juice	Spray Folidol, if severe	Avenue trees very often suffer badly from the 'black scale'
TEAK			
Leaf roller	Caterpillars feed on leaves inside rolls	Spray BHC	
Teak defoliator	Caterpillars defoliate the plants	Dust BHC or DDT 5%	Adult is a yellowish brown moth
CASUARINA			
Bark Caterpillar	Caterpillar girdling bark and often causes severe damage	Scrub the bark with a brush of thick bristles and spray BHC	This insect attacks many trees
ASOKA			
Stem borer	Boring into the stem or between stem and bark in galleries of wood dust	-do-	Sometimes very bad on avenue trees of different kinds

B. Diseases

Trees	Disease	Control measures
TAMA-RIND	Powdery mildew	Dusting the affected trees with finely powdered sulphur
WOOD APPLE	Leaf spot (minor importance)	No control measures are generally taken
BABUL	Rust	Affected portions (galls) are to be removed. Sulphur dusting may be given
PUNGAM	(a) Tar spot (b) Leaf spot	Removal of affected leaves and spraying with 1% Bordeaux mixture.
TEAK	Powdery mildew	Dusting the trees with finely powdered sulphur
CASUA-RINA	Wilt	Eradication of diseased plant and drenching the soil
PORTIA	Leaf spot	Spraying with 1% Bordeaux mixture
NEEM	Powdery mildew	Dusting the plants with finely powdered sulphur
	Leaf spot	Spraying with 1% Bordeaux mixture
MUL-BERRY	Powdery mildew	Pruning of affected branches and dusting with finely powdered Sulphur
DAL-BERGIA SISSOO	Powdery mildew	Dusting with finely powdered sulphur

Chapter VI

VAN MAHOTSAVA

India is a country where religious traditions are closely bound up with forests. It is in the ancient forests and in the shadow of the hills and mountains that Indian religions and philosophy were born and the spirit of enquiry was nurtured. Veneration of trees and forests is, in fact, a part of the Indian life and thought.

With the progress of civilisation and with the growth of population both the method of life and thought have undergone considerable transformation. The pressure on forests, as a result of the demand for fuel, timber, green leaf, fodder and other forest produce, has continuously grown. This process has led to deforestation on a gigantic scale, with indiscriminate cutting of trees at a pace far ahead of the process of fresh planting. Adverse changes in local climate, water supply in rivers, rainfall and soil fertility are some of the many grave consequences which follow from wanton or thoughtless neglect of tree growth.

In the Soviet Union, mass planting of wide areas with shelter belts of trees around farms is said to have appreciably modified the climate. In U.S.A., during the last depression a big wave of tree planting was taken up by the Civilian Conservation Corps under President Roosevelt's New Deal Programme. No less than 75 million seedlings are said to have been planted by the American youths and 44 million by individual farmers. Similar Governmental or non-official efforts have been taken up in many lands to increase the wealth of the country by planting fuel and timber trees and incidentally improving the health of the people by enriching the fruit resources of the country and above all by developing their aesthetic sense through enrichment of the beauty of the landscape. Thus, tree planting ultimately has an abiding influence on the social and economic organism of a State or country.

Absence or inadequacy of tree growth affects all classes of society and their ways of life. The farmer is obliged to fertilise his lands with less of organic manure and even divert the invaluable cattle dung or farmyard manure from his field to his hearth, causing thereby a progressive decline in yields and impoverishment of his lands. Loss by strong currents of wind or sand storms is enhanced ; the sufferings of men and work animals, who have to toil under the scorching summer sun, is increased ; fodder for domestic animals becomes a problem ; the timber resources are reduced ; the landscape becomes drab and monotonous; the forest resources are depleted; floods, erosion of the soil, diminishing rainfall and a general deterioration in the climatic conditions results.

It is now recognised that the protection of trees is based not merely on sentimental grounds but on hard utilitarian considerations. This is the foundation of the national movement which has become famous under the national festival of Van Mahotsava for planting fruit, shade, flowering, timber and all other types of trees in all possible situations, year after year in an organised manner. This last point is of special importance, for organised planting is the essence of Van Mahotsava. Purposeful planting is essential if denuded hill tops, naked river banks, scoured wastelands or the bleak rugged terrain are to be covered with protective vegetation in an aesthetic manner.

Van Mahotsava was first inaugurated in1950. Its object was to arouse mass consciousness regarding the value of trees and tree crops in the general economy of the country. The record up-to-date of its achievements has confounded critics and belied their foreboding. It seems safe to say that Van Mahotsava has come to stay, that an increasing mass of people have become conscious of the value of tree planting and tree preservation, that more trees mean better cattle, better crops, better living conditions and a more beautiful countryside. A growing mass of people has come to realise that to cut the avenue trees or to turn goats loose to destroy woodlands is nothing short of vandalism. Though the Van Mahotsava movement has yet to spread adequately to prevent

all such pillage or vandalism, it has done much to transform men's minds along with the landscape. While focusing attention on the virtues of tree planting it has also been invested with popular appeal.

Van Mahotsava is not a movement which can succeed without a plan and organisation, assistance and guidance. In the initial phases much help was needed in selecting the site and the material, in the supply of selected plant material, in planting technique, in maintenance of the plant, and in the protection against adverse factors. Mere assistance and guidance will be of no avail if we do not enlist the active and enthusiastic co-operation of the villager. The various Departments of the Government—Revenue, Forest, Agricultural, Highways, Irrigation, Local Boards, Educational, etc., have all to play their part and have done so in the past few years to make Van Mahotsava a success. Such collective sentiment has necessarily to be harnessed in a gigantic nationwide movement like this. The Agricultural and Forest departments are principally responsible for raising nurseries, arranging the supply of seeds and seedlings and giving the necessary guidance. The Government buildings such as the Court Houses, Rest Houses, and residential houses have all to have their compounds planted with trees through the efforts of the respective departments. The public gardens owned by municipalities,corporations or by other agencies, the canal banks and roadsides, the railway lands, schools and college compounds, the village waste-lands as well as the fields of cultivators have all to be stocked or planted up. The Revenue Department can take the initiative in getting the trees planted on poramboke lands and in the Panchayat forest areas. Similar plantings can be done by the Public Works Department.

Nothing is perhaps easier than to plant a seedling. It is however more difficult to nurse and protect it from extinction during its early stages. When exposed to the vagaries of the weather and the voracity of domestic animals, the survival of the plants is not easy. If necessary protection is not provided and favourable conditions for growth are not secured, the

stupendous efforts under the Van Mahotsava Campaign are likely to be nullified.

When we plant a tree, therefore, every thought must be bestowed on its aftercare. The selection of a safe site free from the inroad of domestic animals is the first of the prerequisites for success. By far the most economic and effective tree guard is that made of thorny branches of twigs, which can be secured firmly on the ground all around the plant and tied up. Such protection for the trees requires to be constantly repaired or replaced. It is also possible to protect a plant by raising a live hedge around it of a thorny plant like Babul and *Prosopis*, but such hedges should be far away so that they do not compete with the plant inside. Village fabricators can also prepare tree guards out of scrap or old materials like tar drums. Watering the plants regularly from the date of planting till they establish themselves, and particularly during the periods when the heat of the sun is intense or where soil becomes dry quickly, is a very important operation. As important is the timely draining of the excess water from the pits or in the soil around the plant, so that the plant roots do not get strangled or rotted. It would be useful to hoe the plant around lightly, once every month. Elimination of weeds and grass by pulling out these and thorough hoeing is not less important than the exclusion of cattle. A protective cover with thatched grass is also useful to the young plants against the severe summer sun or against frost, which is common on very high altitudes in South India and causes severe damage to the plants of the tropical kind such as the mango, the jack and the banana. At the time of planting out and in the early stages, a reduction of the number of shoots and prevention of too much shoot growth near the ground is desirable so that the terminal growth and the shoots on the higher regions of the plant may grow quicker and better.

When Van Mahotsava was originally started, the tree planting week was celebrated in August so that it may synchronise with the Independence Day. But it was soon realised that in most parts of the country the monsoon sets in with the commencement of July or a little earlier and, there-

fore, the first week of July was fixed as the national tree planting week from 1951 onwards. This no doubt deprived the movement of the benefits of the collective national sentiment associated with the Independence Day, but through the association of the Van Mahotsava with forest festivals, fairs, regional, religious or other events, invitation to national leaders, gatherings of cultivators, agricultural associations, congress committees, etc., it has gradually developed into an eventful national festival.

The earliest national report compiled on 23-1-51 by the Government of India stated that "the reports received to date from the various States indicate that the response to the Hon'ble Minister's appeal to plant a crore of trees exceeded expectations. In fact, a little over three crores of trees were planted, which placed fifteen feet apart would cover an area of 150,000 acres." Even if one out of every five plants survives, the surviving trees would therefore work out at 60 lakhs. This is by no means a big achievement for a country of the size of India. What is important, however, is the cumulative effect of sustained effort over a series of years. Van Mahotsava has generated national enthusiasm, which, if fostered and sustained, is bound to bring lasting benefits to the country.

The Government of India have instituted a number of national awards to stimulate tree planting. The Rajendra Shield is awarded annually for the district adjudged to have done the best work and the first award of this shield was made to the district of South Kanara. The Jawahar Shield is awarded to the village adjudged to have done the best and this, too, was awarded in 1951 and 1952 to two villages in the Madras State viz., Periyaram and Ullal respectively. The Sardar Patel Shield and the Munshi Shield are awarded to an Institution or University for similar excellence of work. The latter shield was won by the Andhra University in 1952 and by Annamalai University in 1953. South India has, therefore, given a good account of herself. With sustained vigour and enthusiasm she can remain in the vanguard of national effort.